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ELECTRIC RAILWAY MACHINERY AND APPARATUS—28

THE GANZ THREE-PHASE LOCOMOTIVE

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THE appearance of a Ganz three-phase locomotive can be seen in Fig. 275. This engine is of the 6-4 type arranged so that each end pilot axle and the adjoining driving axle are held in a truck connected with the main frame by means of a king pin. The middle driving axle is held in the locomotive frame. The two other driving axles have an end play of about one inch. One of the king pins has a side movement of about an inch, but the other one is held rigid so that the truck it holds can only have a swiveling motion.

Design of the Motors

The motors of the Ganz three-phase locomotive are decidedly different from those used with the motor cars described in the last article. Instead of using two separate motors for each pair connected in cascade, a single machine is used which is a twin motor. In the motor cars, the motors are mounted concentric with the axles, but in the locomotive they are placed between the three driving axles, and the motion is transmitted to the latter through connecting-rods. This change was made because with these induction motors the field is made in the form of a solid ring, therefore, to remove it from the axle it is necessary to take off one of the driving wheels, which is not an easy or desirable operation. The external appearance of the locomotive motors is shown in Fig. 276. The armature shaft is journaled in the end frames of the motor field, and also in the main frame of the locomotive. This construction is used because in induction motors it is necessary to run the armature with a very small clearance between its core and the field magnets. The portion of the shaft that rests in the locomotive frame bearings is seen projecting from the field frame, and immediately in front of this is the crank. The crank on one side is made double so as to carry collecting rings through which electrical connection is made with the wire coils on the armature. These collecting rings are enclosed in a sheet iron casing which is shown suspended beneath the cab a little to the right of the door. For the purpose of reducing the face of the rings the collector brushes are made narrow, and as many of them as is necessary to give the proper amount of contact surface are placed around the periphery of the rings. The way in which the collector rings are held, and also the way in which the wires run from them to the armature coils is shown in the sectional drawing of the motor Fig. 277. The primary field ring of the motor is located at *F*, and its armature at *A*. The connecting wires run from the collector rings which are carried outside of the crank-pin, through openings in this pin and the cranks, to the hollow shaft, and thence along the path *A′* to the armature coil terminals. The bearings for the armature shaft held by the field frames are also shown, and also the main frame bearing portions of the shaft which are at *S′*. When the motors are running in cascade connection, the coils on armature *A* are connected with the coils on armature *B*, and the coils of *F2* are connected with the regulating rheostat. When the motors are connected for high speed, the coils on *A* are connected directly with the rheostat through the collector rings, and then the second motor, consisting of armature *B* and field *F2* is dead.

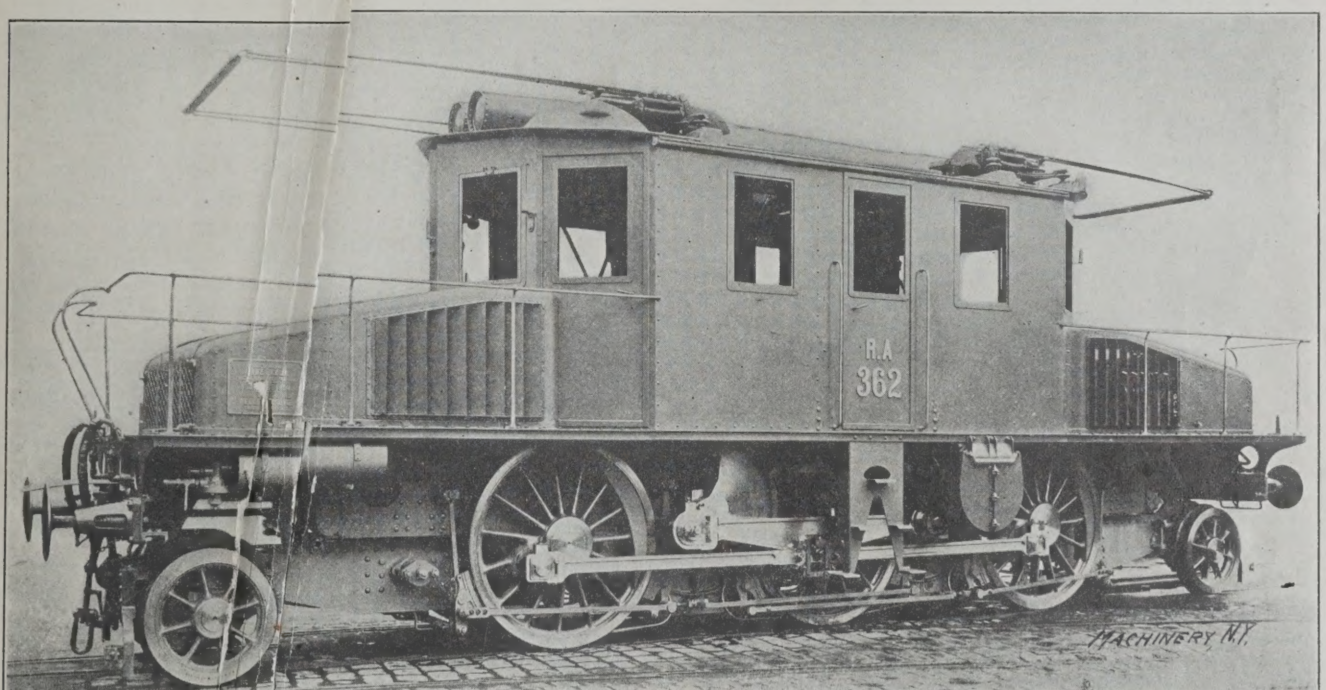

Fig. 275. The Ganz Three-phase Electric Locomotive

General Construction of the Locomotive

The construction of the locomotive is shown in the line drawings of Fig. 280. The middle drawing is a side elevation of the whole engine. Just below this is a simplified side elevation of the main frame and the two end trucks that carry the pilot wheel axles. The upper drawing is a top view, the right-hand side showing the truck, with the location of one of the motors at *M*, the collector rings on one end of the shaft at *A*, and one of the end trucks, the king bolt of which is at *B*. Looking at the elevation it will be seen that the crank-pins of the two motors are connected by a bar which

engages directly with the crank-pin on the center driving wheel. The brasses of this pin slide in a vertical slot in the driving rod, so as to permit of free vertical movement of the crank-pin with reference to the bar. The connecting-bars that drive the two outer axles are attached to studs on opposite sides of the slot in which the center wheel crank-pin moves. The motors are shown in broken lines between the axles, and each one is supported from the main locomotive frame by means of four suspension bolts. The cranks on the opposite ends of the motor shaft are set at right angles to each other, so that there is no danger of getting them on a "dead center" or in a position where they would be incapable of rotating the driving wheels.

The Trolley used with the Locomotive

The trolley used with the locomotive is substantially the same in construction as the one described in connection with the motor cars, in the last article. In its operation it is slightly different, the difference being that it is arranged so that the pressure with which it presses up against the trolley wires can be increased automatically as the speed

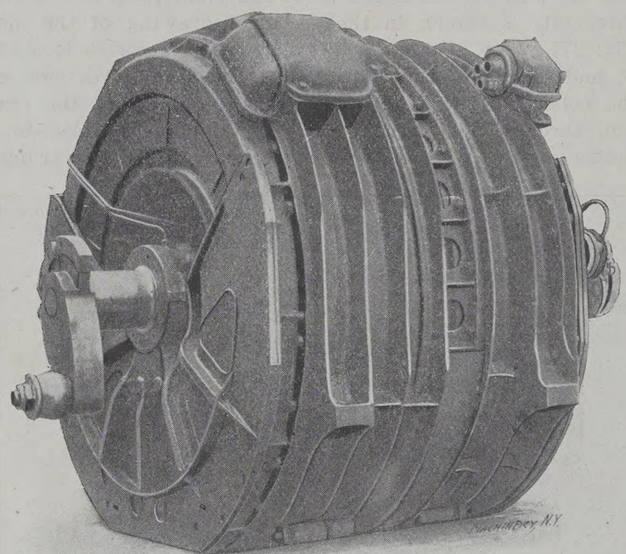

Fig. 276. Three-phase Twin Motor. The High and Low Tension Motors are on One Shaft and both take Current from one set of Contact Rings

is increased. This is accomplished by providing two pistons in the cylinder that draws out the lifting springs. The parts of the cylinder in which these pistons move are connected with the pneumatic controller. The piston that is actuated when the locomotive runs at a low speed has a shorter stroke than the one that is actuated when the engine is connected to run at high speeds, hence when the latter piston moves it draws the tension springs out further and thus

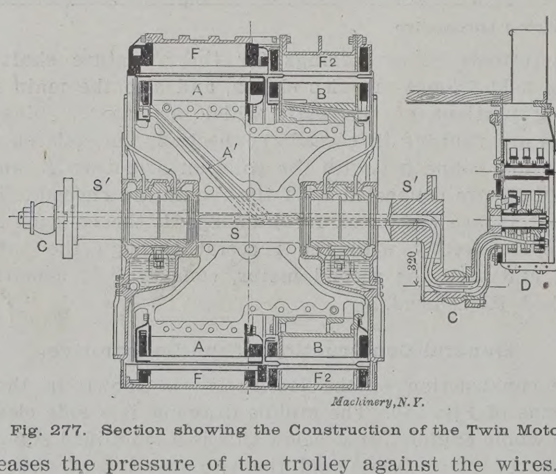

Fig. 277. Section showing the Construction of the Twin Motor

increases the pressure of the trolley against the wires. This arrangement was devised because it has been found that at high car speed it is necessary to have greater pressure to cause the trolley to make good contact.

The main switch of the locomotive is the same in construction as the one used with the motor cars, with the only exception that instead of being rotated by hand to reverse the direction of rotation of the motor it is rotated by a pneumatic cylinder.

The Main Controller of the Locomotive

The main controller of the locomotive is operated by compressed air, and not manually as is the case with the motor car controller. The appearance of this controller is shown in Fig. 278. It is provided with three operating handles. One of these handles controls the cylinders in the main switch which rotate the disk carrying the contact plugs, when it is desired to reverse the direction of rotation of the motors. Another handle controls the cylinder that moves the switch by means of which the motors are cut in or out of cascade connection so as to vary the speed. The third handle controls the flow of air into the chamber of the water rheostat so as to cut out the resistance in starting. These three handles are interlocked so that they cannot be moved except in the proper order, just as is the case with the hand-operated controller described in the last article.

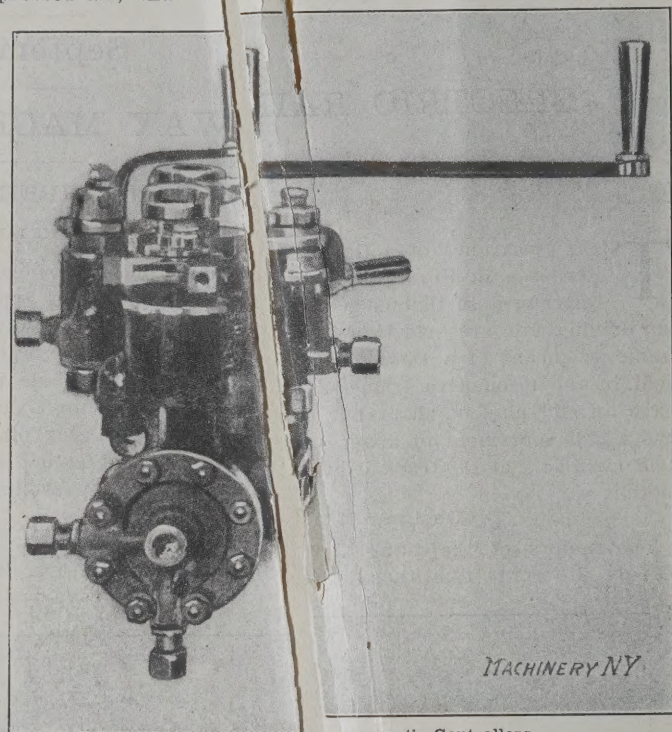

Fig. 278. Electro-pneumatic Controllers

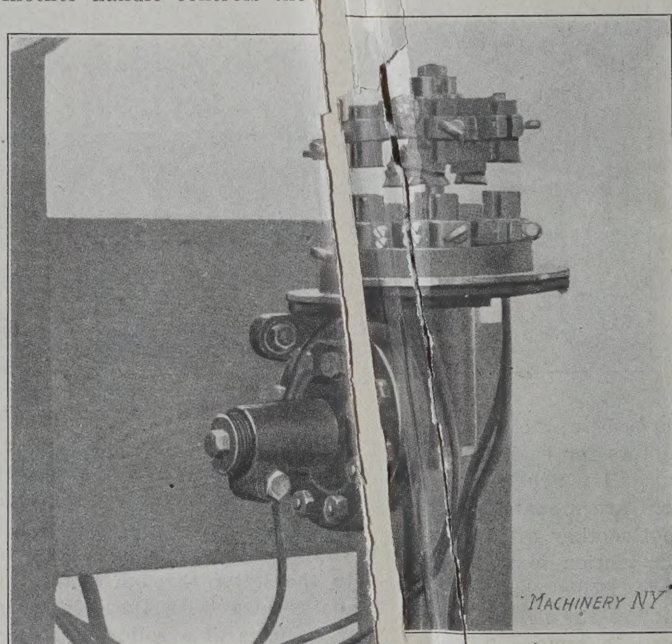

Fig. 279. Mechanism which automatically controls the Air Compressor

Automatic Air Compressor Controller

An automatic air compressor controller is also provided so as to stop the motor that actuates the air compressor when the pressure is too high, and start it when the pressure runs down below the proper point. This controller is shown in

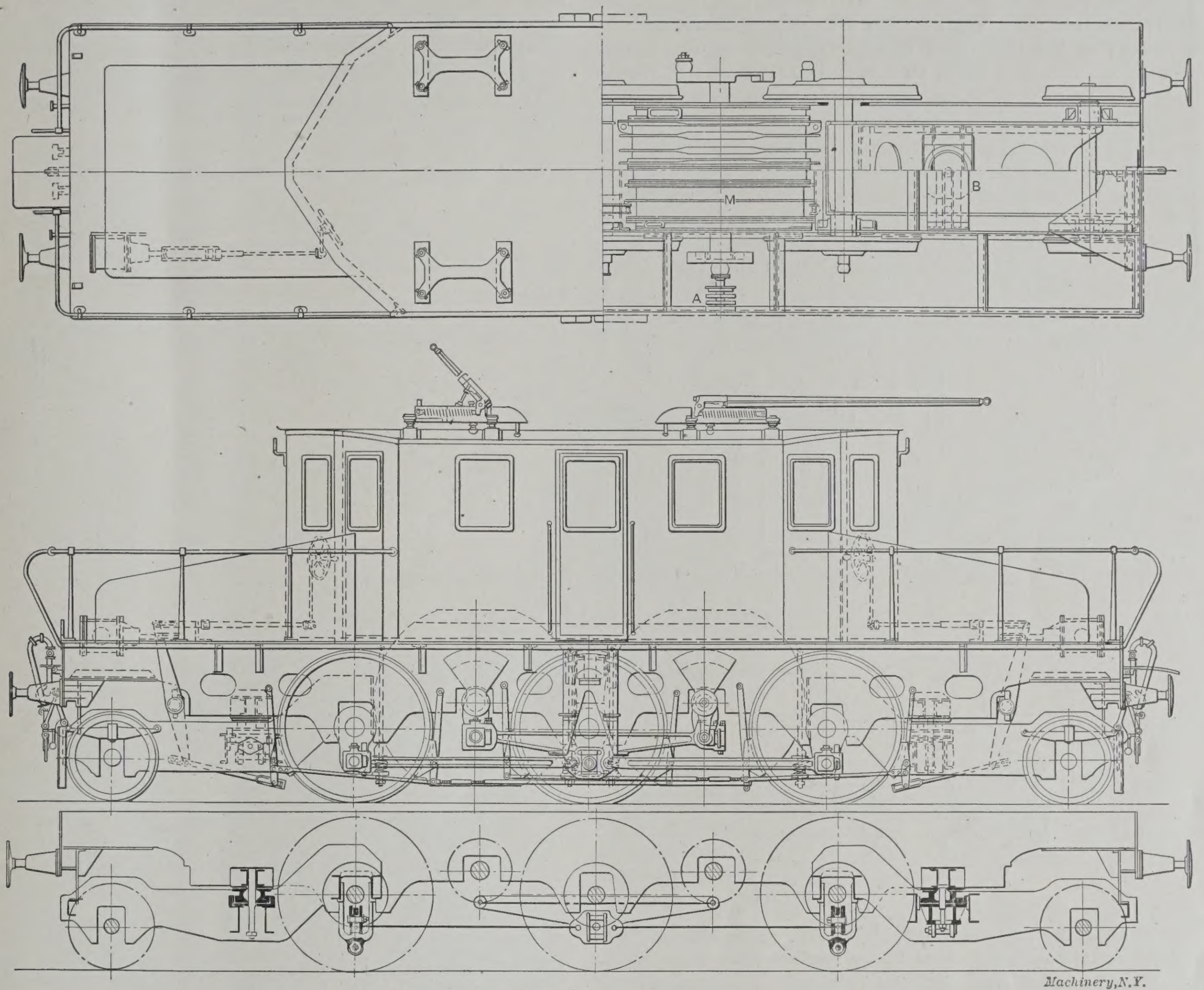

Fig. 280. Plan and Elevations of the Locomotive shown in Fig. 275

Fig. 279 and consists of a switch to open and close the motor circuits, and a compressed air cylinder to actuate the switch. When the pressure rises above the proper point the movable part of the switch is raised and the contacts are separated, thus opening the motor circuits.

The Pneumatic Speed Controller

The pneumatic speed controller is shown in Fig. 281. This apparatus is simply a switch that is moved by compressed air so as to change the motor connections and thus change the speed. In its normal position the movable part is held down by the air pressure, and as long as it is in this position the motors are connected in cascade, and the engine runs at low speed. To pass to high speed, air is admitted under the piston and the switch contacts are carried upward; this breaks the cascade connection and connects the primary motor armature directly with the rheostat and leaves the second motor dead so that the high speed may be attained. The illustration shows this controller with the casing removed, and one of the movable switch contacts can be seen on the front side, and the bars of the other two can be seen just back of it. The external appearance of the water rheostat is shown in Fig. 282.

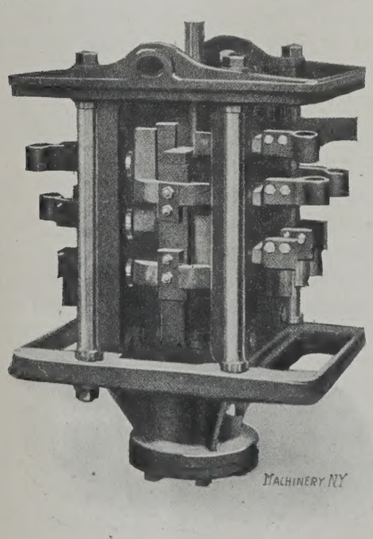

Fig. 281. Pneumatic Speed Controller which changes the Motor Connections

Arrangement of Apparatus in the Locomotive Cab

The arrangement of the apparatus in the locomotive cab for operating the motors, the trolleys, the brakes, etc., is shown in Fig. 284. The main motor controller, which is shown in detail in Fig. 278, is seen just below the window at the left side. The indicating instruments seen above the controller are for the purpose of enabling the motorman to judge by the strength of the currents and the voltage, just how fast to move the handles. In the descriptions of the controlling apparatus of the General Electric and the Westinghouse railway systems it will be recalled that in some of them, which are called automatic controllers, the various parts are so made that it is not possible for the operator to manipulate the con-

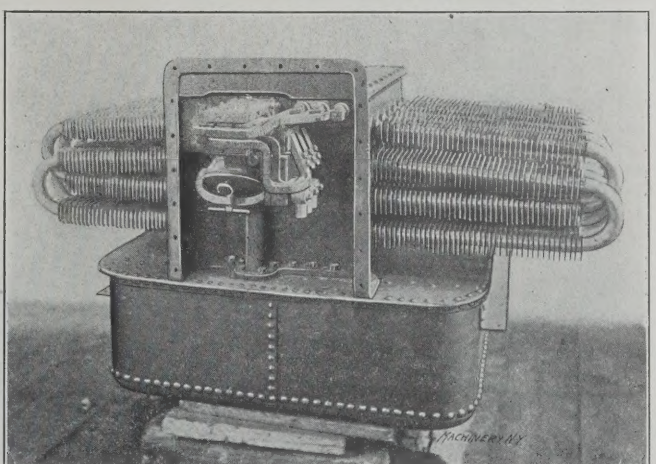

Fig. 282. The Water Rheostat

troller so as to accelerate the motors too rapidly. In the apparatus here described no such provision is made, and the judgment of the motorman is relied upon to secure proper operation. This is a point on which American and European designers differ; the former strive to make things "fool proof," as it is called, so that under any conditions the operation may be satisfactory, but the Europeans are more willing to trust to the intelligence of the men who handle the apparatus. The devices other than the controller are for operating the brakes, the trolley, the sanders and other devices.

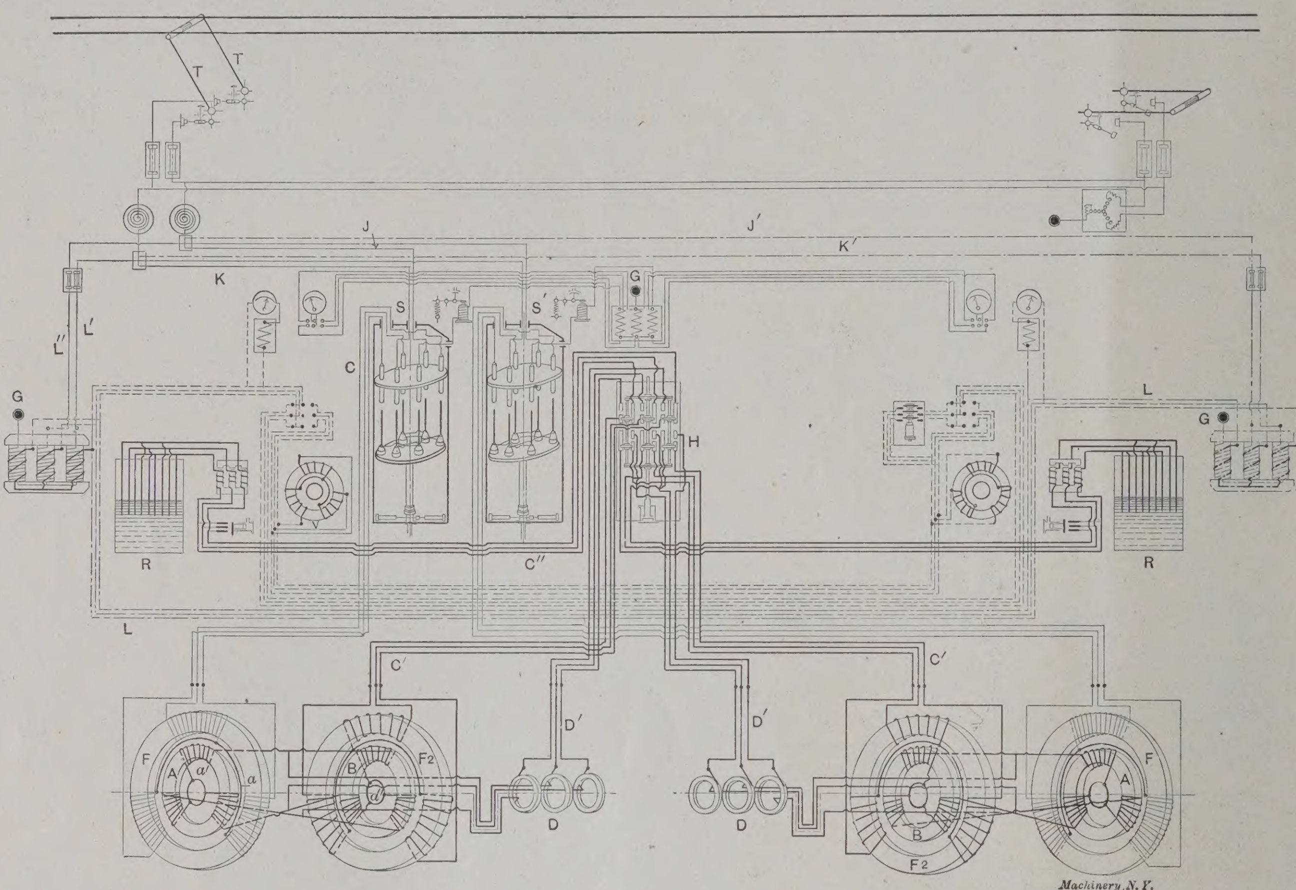

Fig. 283. Wiring Diagram for the Ganz Three-phase Electric Locomotive

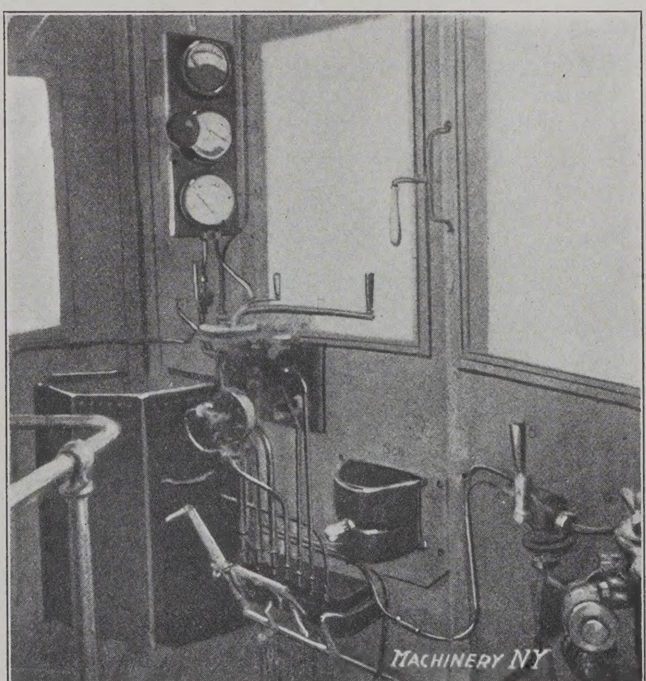

Fig. 284. A View of the Controlling Mechanism in the Motorman's Cab

The arrangement of all the apparatus and the connecting circuits in the Ganz three-phase locomotive is fully shown in the wiring diagram, Fig. 283. The main controller is shown at *H*. In the motor car diagram it will be recalled that there are two controllers shown. These are mechanically connected, so that the movement of one actuates the other; but in the locomotive this mechanical connection is obviated by using a single controller having the necessary electrical connections to actuate both sets of motors. The collector rings of the motors are shown at *D*, and the brushes that bear on them are connected with the controller by the wires *D′*. When the motors are running at half speed the circuit of the wires *D′* is opened, and then the current induced in the coils wound on armature *A* passes through the coils on armature *B* and, in turn, induces currents in the coils wound of *F*2. The coils on *F*2 are connected with the controller *H* through wires *C′*, and if the controller is turned to the slow speed, cascade connection, they will here be connected with the wires *C″* that run to the rheostats *R*. Then by reducing the resistance in the rheostats the speed is accelerated from zero, when starting, to full half speed, when all the resistance is cut out. To increase the velocity to full speed, all the resistance of the rheostats is cut back into the circuit, and the connections between wires *C′* and *C″* are broken while the connections between *D′* and *C″* are closed. Then as the resistance is again gradually cut out of the circuit the speed increases until the full velocity is attained.

* * *

A project is on foot for building an international dam across the Niagara River to maintain the water level of Lake Erie at not less than a certain minimum height, the year round. Every Autumn the level falls so as to seriously interfere with shipping, and it is for improving the present condition that the dam is considered. If built, the dam could be used for another purpose equally laudable and valuable. There has been much agitation against the defacement of the natural beauty of Niagara Falls because of the amount of water used by the power companies which materially reduces the volume of flow over the falls in low water periods. The dam could be used to impound water at night, practically cutting off all flow for certain hours through the night and storing it up for use in the daylight hours. In this way it would be possible for the power development of Niagara Falls to be materially increased for daylight service without decreasing the normal volume of flow, the daylight flow being sufficiently in excess of the normal flow to compensate for that used by the power concerns.

AN AMERICAN STEAM MOTOR CAR

FRANK C. PERKINS*

During the past decade the steam motor car has been developed to a high state of perfection in Europe, and has entered the field of urban and interurban service with the gasoline motor car in competition with electrically-operated motor cars. In the United States, however, little has been done in this line until recently.

The construction of a novel motor car recently built by the St. Louis Car Co., St. Louis, Mo., is shown in the accompanying illustration. This car is utilized for passenger service, and it is provided with a baggage compartment and seats for the accommodation of 38 passengers. Although this was not designed for freight service, its capacity for hauling trailers or freight cars in an emergency has been demonstrated by hauling a train of freight cars weighing 520,000 pounds, without difficulty. The car has a total length of 37 feet 3 inches, a width of 9 feet 2 inches, and it weighs complete, without passengers, 66,000 pounds. There is included in this weight, 6,600 pounds for water and oil, the latter being utilized as a fuel instead of coal. It is claimed that this car is

Steam-propelled Car for Passenger Service, built by the St. Louis Car Co.

capable of developing a speed of 40 miles per hour on a level track. It is designed for hauling not more than two trailer cars or two express or freight cars under normal conditions, although in an emergency longer trains can be handled.

The engines of this car are hung to the motor truck, but the car body carries the water tube boiler which supplies steam to the cylinders at a pressure of 200 pounds per square inch. The engines develop 125 horse-power, and are capable of driving the car at the above mentioned speed of 40 miles per hour with 200 pounds steam pressure, and on a level track. It is maintained that the use of crude oil for making steam is most convenient and cleanly, there being no dust nor dirt as when coal is used, and the combustion in the firebox is complete.

While the primary object aimed at, it is said, in the development of this design was to provide a self-contained steam motor car for passenger service, still, considerable freight and express may be handled when necessary and a number of trailers may be hauled during heavy passenger service on extra occasions when required.

* * *

The high speed of the vessels of the British navy is proverbial, but few people realize that the English navy possesses twenty-six armored ships exceeding twenty-three knots in speed, and sixteen unarmored ships with the same speed capacity. Six of the armored ships are capable of a speed of twenty-four to twenty-five knots and over.

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OBSERVATIONS ON THE MAKING OF HIGH-SPEED STEEL TOOLS

O. M. BECKER*

The collection and orderly preservation of data as a basis for subsequent rational deduction and intelligent procedure has long been considered an essential concomitant of the scientific method; and it is now coming to be pretty generally understood that the scientific method is also the successful business method, whether the end sought be the perfection of technical processes or the organization of a business system. The preservation of appropriate data as a guide to the production of superior high-speed steel tools by the simplest efficient methods, should, therefore, need no arguing. The sneer of the small man in a small place at "red tape"

TOOL RECORD

Tool Name.........Size ....No.....Lot No.....
For Piece No.......Operation No.......Department ....

Steel ....Analysis: C...T...Cr...Mo...
Critical Point .... S...Si...V... ....
C. P. Determined.............Analysis Determined ....

Forging Temperature.........Forge No.......Smith.........
Hardening Temperature.......Furnace No.....Operator......
Tempering Temperature.......Furnace No.....Operator......
Ground before Hardening?....Finish Grinding by..........
Date Finished................Checked by ....

Memoranda ....
....
....
....
....
(Signed)

and "over-refinement" is not heard nearly so much as formerly; and this is as it should be, especially as regards the manipulation of the new steels. The question under consideration concerns not alone the keeping of data, but, more particularly, the kind of data to be kept.

Kind of Data to Preserve

Within moderately well established limits the precise treatment best calculated to develop the highest efficiency in a tool intended for a special purpose is usually found by the "cut-and-try" method. It is desirable, therefore, that besides the record of the performance of the tool, there should be data showing the precise conditions under which the tool was treated while in process of manufacture. These conditions are comprehended in the tool record shown herewith;

DIRECTIONS TO TOOL-MAKERS

1. Lot No...
2. Kind of Tools......................................
3. Steel to be Used...................................
4. Class of Work on which Used........................

5. Hardening Furnace ....
6. Temperature ....
7. Method of Cooling..................................
....
8. Temperature of Bath................................

9. Method of Tempering................................
10. Tempering Furnace ....
11. Temperature ....

12. Memoranda ....
....
....

Completed ....
(Signed)

once definitely known, they can be varied from time to time as may be indicated by the results obtained from the tool at work. Obviously, when a set of conditions is found which yields just the proper excellence, it is necessary only to duplicate these conditions to obtain satisfactory results. The proper conditions will then be definitely indicated in the directions accompanying each subsequent lot of tools of the kind. It will be understood, of course, that there is small value in such data and directions unless the tool manufacturing plant is equipped so as to take advantage of this information; that is, unless the plant has a variety of fur-

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naces and other apparatus suitable for obtaining accurate information as to conditions, and for meeting the requirements indicated upon the direction cards. Time spent in experimenting intelligently—that is, experimenting with adequate appliances, materials and data—to fit the tool most nearly to its work, and to give it treatment which will produce the highest attainable efficiency in its special work, is well and profitably spent.

Hardness or Temper of High-speed Steel Tools

Of the elements involved in tool efficiency, hardness or temper formerly was considered the most important, the design and conditions of use being little regarded. At the present time, the intelligent making of high-speed tools involves a consideration of all these and other elements, relegating to hardness or temper its appropriate place. The extreme hardness of many of these tools has frequently led to the inference that a tool has been properly treated if it is very hard, so hard that a good file will not "touch" it. However, extreme hardness is not always an indication of the efficiency of a high-speed tool; although it is necessary in certain classes of work (cutting refractory stock, for instance), in others it not only is unnecessary, but perhaps even undesirable. As a matter of fact the largest users of the best makes of high-speed steel find that for many purposes tools do the best work and give the most efficient service when soft enough to be "touched" by a good file, and even when so soft that it will "take hold." However that may be, the file test for high-speed tools is quite valueless even in those cases where it is desirable that the degree of hardness be determined. Such tests, to be of value, would require that the files must be absolutely uniform in temper. Even the best of files, however, vary more or less in temper and hardness; and a tool passed as "hard enough," when tested by one file might easily fail to pass the test when tried by another, presumably of the same temper.

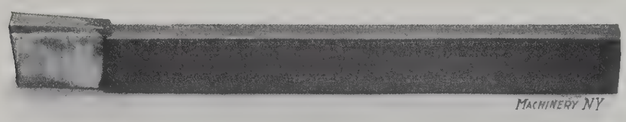

Fig. 1 Planer Roughing Tool with Machine Steel Shank and High-speed Steel Cutting Edge composed of a Comparatively Thin Piece of High-speed Steel brazed to the Shank. Used in the Shops of the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio

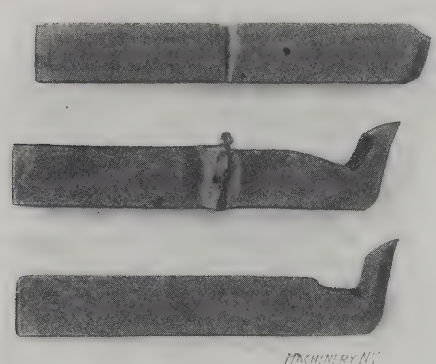

Fig. 2. Diamond-point Lathe Tool made with High-speed Steel Cutting End electrically welded to a Mild Steel Shank. Courtesy of the Thompson Electric Welding Co.

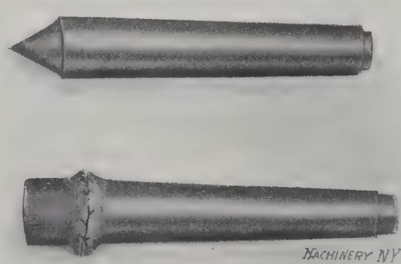

Fig. 3. Lathe Center made with High-speed Steel Point electrically welded

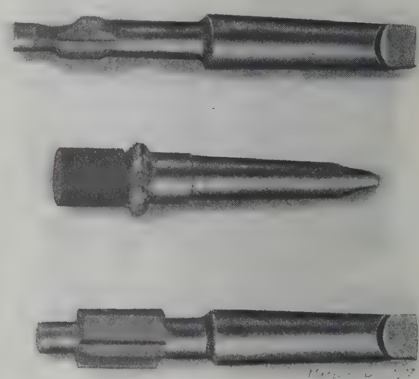

Fig. 4. Broken Counterbore Repaired by Electric Welding

Allowances to be Made for Variations in Sizes of Tools After Hardening

Usually it is of no particular consequence, in tools of the lathe or planer type, whether the stock is exactly sized or not, so long as there is enough material to withstand the enormous strains and to prevent vibration, and consequently inferior and inaccurately sized work. In other types of tools, however, as in drills and mills, it is necessary, when ordering stock, to make allowance for the burnt skin which must be removed after hardening. While the effect on high-speed steel is apparently much less marked than in the case of the carbon steels, nevertheless the long-continued high heat in annealing affects the surface of the bars enough to make it necessary to remove the same to a depth varying more or less according to the size of the bar. In stock above an inch in thickness one-eighth inch should be added to the required size, and in large sizes, the proportionate allowance decreases rapidly.

The allowance for shrinkage of finely-sized tools during the hardening process is distinct from the allowance just mentioned. Loss in size is almost invariably the result of exposure to the air while the tool is very hot. The loss due to actual shrinkage is so small, except in large tools, as to be scarcely appreciable, and is usually negligible when the barium chloride process is used. If the hardening is done by the customary methods, a slight allowance is possibly desirable in certain cases, say in the arbor holes in milling cutters, the diameter of taps, etc. With care in hardening, even by the customary processes, the variation in a 1-inch diameter will scarcely exceed 0.0005 inch, and more likely will be less, though indeed it may be as great as 0.001 inch and even more—so much depends upon the care exercised and the method employed. It should scarcely need to be added that the holes in all mills intended for very accurate work should be ground after hardening, the mills having been first carefully centered in a chuck.

It might also be mentioned that apparent variations in the size of tools like threading dies and taps and other tools which cannot be ground after hardening, are frequently only the effects of the roughening of the surface during the treatment. The barium process very largely overcomes this difficulty and does so entirely, unless, as is generally the case, the defect is present before the hardening. This roughness usually arises from the method of cutting the threads, or teeth, as the case may be. Such threads or teeth are best, and of course most quickly, cut by milling, lubricating the cutter with thin oil. Next to this it is best to rough out the threads with a chaser, as close to size as may be, without lubricant, and then to re-cut or finish with a single-point tool held in a spring-thread holder, the threads being kept slightly lubricated with very thin oil. To compensate for the roughness often present in high-speed tools of this class, it is customary to give rather more relief than in the case of those made of ordinary steel. The increased relief minimizes the lodging of particles of steel in the surface of the cutter behind the cutting edge, which tend to act as cutters, sometimes very appreciably increasing the cut.

Extreme smoothness is also a desirable quality in high-speed drills, but it seems impossible to obtain by present methods of cutting a smoothness of surface like that of the carbon steel drills; to secure this it is necessary to polish the flutes. If the hardening is by the barium process, the polishing may be done before hardening, for that process leaves the surface absolutely unimpaired.

Disadvantages of High-speed Steel Tool-holders

The early method of economizing in steel by using tool-holder stock rather than making the entire tool of high-speed steel, in the case of those tools whose cutting edges or points work without intermission (as those used for turning, planing and similar operations) is open to criticism, and is not

now so generally followed as formerly. A characteristic of the operation of high-speed tools is the rapid generation of heat in the cutting edge. In the case of milling cutters and kindred tools this is of small consequence, because the cutters are intimately attached to a relatively large mass of metal which conducts the heat away very efficiently. Furthermore, these cutters work intermittently, each for a very brief space of time, and for the remainder of the revolution are exposed to the air and cooled by it. The cutting edges are not allowed, therefore, to get exceedingly hot, as is the case with the edge of a turning tool run at the same speed. It is necessary that the body of such a turning (or similar) tool be large enough to conduct away a considerable portion of the heat generated at the cutting edge; and in order to do this effectively the tool must be continuous; that is, there must be no appreciable separation between the part of the tool which does the cutting and the body from which most of the heat radiates, as there is ordinarily when a small piece of steel is held in a tool-holder. There are indeed tool-holders which minimize this difficulty; but even these are not satisfactory in large sizes.

Methods of Uniting High-speed Steel with the Tool Body*

From the first, methods were sought whereby high-speed steel cutting points could be intimately combined with tool bodies of ordinary and much cheaper steels. For the most part the methods tried were ineffective and impracticable. The reasons are not well understood. The disinclination of the two steels to unite probably is due to a difference in their coefficients of expansion. There is, however, no trouble in brazing them together; and when this does not involve placing a great strain upon the brazed joint, this method does very well. Obviously the cutters are hardened before being brazed into place. A successful example of such a combination is a lathe or a planer tool made with practically no forging and with a relatively thin plate of high-speed steel brazed to the front and top to form the cutting edge. Rose and other forms of reamers and mills have been made in a similar way, the body of machinery steel being machined with recesses for high-speed blades, which are brazed into place. Such tools have been in use for several years, with satisfaction. The latter, especially, are as good as if of solid high-speed steel except when it is essential that they be re-annealed or re-hardened—which is seldom necessary.

Almost as soon as the new steels made their appearance the writer suggested and demonstrated the possibility and feasibility of welding, electrically and autogenously, a high-speed cutting point and a machinery steel tool body, the latter of such proportions, of course, as to give the requisite strength to the tool. Such tools conform to the requirement of being perfectly continuous, and the weld is practically as strong as the rest of the tool. It is feasible to forge the end to any required shape as if the entire tool were of high-speed steel; and, since in hardening only the nose is heated to a high heat, the machinery or tool steel body is in nowise impaired. The method of electrical welding, as used in this connection, is exceedingly simple. The two pieces to be welded are attached to the terminals of a circuit of suitable voltage, and the edges brought together. The resistance to the passage of the current offered by the imperfect contact sets up enough heat to melt the metal and forms a perfectly homogeneous junction. The autogenous (oxygen and acetylene blow-pipe) method is almost as simple; the flame is directed into the crevice where the two pieces are brought together, and melts the adjacent metal so as also to form a homogeneous joint.

Another method (patented) recently brought forward, somewhat resembling brazing, is asserted to give a joint fully as strong as the rest of the tool. A thin film of copper is placed along the line of the joint, and the parts to be welded are surrounded by a reducing compound and then placed in a furnace raised to a temperature of about 1,200 degrees C. (2,200 degrees F.). The copper flows freely into the interstices and is said to produce actual cohesion between the adjacent molecules, making a perfect joint, so strong that a fracture will follow a new break rather than pass through the joint.

* See MACHINERY, October, 1908, "Electric Welding of Tools."

These methods are available for all classes of tools made partly of high-speed and partly of machinery steel or other materials. Reamer and mill blades, die faces, shear blades, jack knives, etc., all are readily welded to supporting forms or backs and make tools quite as efficient as if of solid high-speed steel—and generally much more so than if the cutters or faces were attached by screws, bolts, rivets, or similar methods. Long-shank and extension drills, reamers, etc., can readily be made with the cutting parts of high-speed steel and the shanks of cheaper steel. The processes mentioned, especially the electrical, are available also for the repair of broken tools, many of which can thus be saved for further use. The repairing may involve the welding of the broken parts or the replacing of an old part by a new, as may be most expedient.

Cutting High-speed Steel

Only an expert can nick and break high-speed steel from the bar without damage to the structure adjacent to the fracture—and even an expert cannot be sure of doing so with safety; the best way, where the end is to be used for working purposes, is to cut the bar. The circular saw most frequently used does very well, though a band saw works better and rather more rapidly. Small bars can readily be cut in bundles, if held very rigidly. The saws, obviously, should, themselves, be of high-speed steel. Complaints have been made that it is impossible to saw these steels. The complaints probably originated in the use of improperly hardened saws; for there is no difficulty whatever in cutting them with suitable saws. A singular but most effective method has been employed to some extent. It consists in the use of a highly-speeded disk of tough steel. When an unused disk is first forced against the high-speed steel, the disk does not take hold well; but after being run in contact with the high-speed steel for a time it cuts perfectly and rapidly, leaving a clean burless kerf. The disk may be of any steel tough enough to withstand the tremendous centrifugal (and other) stresses set up by the pressure and the terrific speed required. Just why such a disk cuts is not exactly clear. The periphery is usually found studded with particles of the steel being cut, and the "sawdust" appears to be the result of true cutting.

Detecting Cracks in High-speed Steel Tools

Fine cracks in tools are most difficult to discover. Even the microscope often fails to disclose them. Generally they can be detected, if present, by the very simple expedient of moistening the suspected surface with petroleum, rubbing clean, and then wiping off with chalk. Some petroleum enters the cracks and afterwards sweats out, moistening the overlying chalk. The nature and extent of the cracks are thus rendered visible. This frequently is of great importance in testing lots of high-speed steel tools.

Re-forging of Worn-down Tools

Tools which have worn down so as to be useless can usually, when made of solid high-speed steel, be forged or machined down and worked into tools of smaller size, if ordinary care is exercised. It is necessary always to re-anneal prior to attempting to machine such old tools; and it is also expedient when forging them to smaller shapes. In passing, it might be mentioned that re-annealing is desirable after machining and before hardening all sorts of intricately-shaped tools, in order to relieve any possible machine-caused strains. In re-forging high-speed tools, whether for reduction in size or merely in re-fettling, it is desirable that they be heated rather slowly at first; they should not be thrust cold into a very hot fire.

* * *

An alloy of iron and thorium which possesses remarkable properties has been produced by Mr. Welsbach, the well-known inventor of the incandescent gas mantel. When struck lightly against a piece of iron this alloy emits exceedingly bright sparks, and sufficient heat is developed to ignite tinder instantaneously without the repeated efforts required with the old-fashioned flint and steel. The new thorium flint may be called an everlasting match, and will undoubtedly be very useful to explorers and tourists and for the ignition of explosives.

CALCULATION OF PILLAR CRANES*

CHARLES A. SCHRANZ†

The maximum stresses in the different parts of a pillar crane are due to the maximum load lifted (the live load) and the weight (dead load) of the crane parts themselves. Fig. 1 shows a conventional design of a hand pillar crane, and assuming, for an example, the maximum load $Q = 5$ tons, the height $H = 12\frac{1}{2}$ feet, and the radius $A = 13$ feet, the stresses in the different parts of the crane are calculated as shown in the following.

Stresses in the Boom

Fig. 1 shows plainly that the stresses in the boom and tie-bars are not due to the live load only, but that the weight

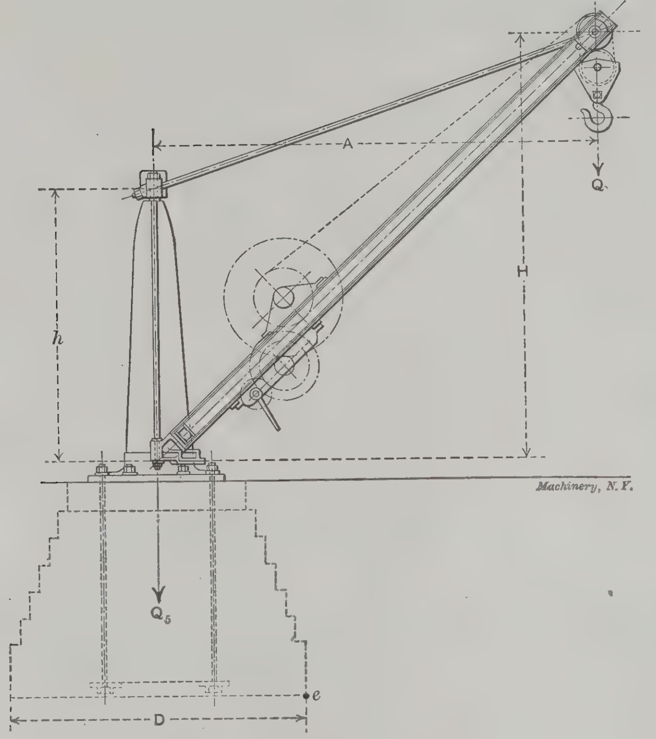

Fig. 1. General Layout of Pillar Crane

of the eccentric parts of the crane (*i. e.*, boom, tie-bars, hoist, sheave wheels, crane hook and hoisting rope) and the pull of the hoisting rope must also be considered. As it is not possible to determine the dead load accurately before the crane is calculated and designed, it must be assumed. A practical method is to assume the weight of the above mentioned eccentric parts of the crane as half of the maximum live load, and its center of gravity at a distance equal to one-fourth of the radius of the crane from the center line of the pillar. These assumptions expressed in formulas read:

$$Q_1 = \frac{Q}{2}; \text{ or } Q_1 = \frac{10{,}000}{2} = 5{,}000 \text{ pounds.} \qquad (1)$$

$$a = \frac{A}{4}; \text{ or } a = \frac{13}{4} = 3\tfrac{1}{4} \text{ feet.} \qquad (2)$$

in which $Q_1 =$ the weight of the eccentric parts of the crane, and $a =$ the distance of the center of gravity of Q_1 from the center of the crane. If the actual figures, determined after the crane is calculated, differ considerably from these assumptions, corrections have to be made.

The next step is to determine the height h of the pillar, a practical rule being to make h about 0.6 of the radius of the crane:

$$h = 0.6\,A; \text{ or } h = 0.6 \times 13 = 8 \text{ feet, approximately.} \qquad (3)$$

The frame diagram shown in Fig. 2 can now be drawn. According to the law of equilibrium the sum of moments of the external forces must be equal to the sum of moments of the internal forces about the same center. The moment M_i of the internal force in the boom is the product of its compressive stress C and its lever arm e ($5\frac{3}{4}$ feet) about center K:

$$M_i = Ce \qquad (4)$$

The moments of the external forces about center K are:

$$\text{The moment of } Q = M = Q\,A \qquad (5)$$

$$\text{The moment of } Q_1 = M_1 = Q_1 a \qquad (6)$$

$$\text{The moment of } Q_2 = M_2 = Q_2 b \qquad (7)$$

Dimension b is found to be 4 feet by scaling.

Substituting the values:

$M = 10{,}000 \times 13 = 130{,}000$ foot-pounds,

$M_1 = 5{,}000 \times 3\frac{1}{4} = 16{,}250$ foot-pounds,

$M_2 = 5{,}000 \times 4 = 20{,}000$ foot-pounds.

The sum of above moments is:

$$M_s = M + M_1 + M_2 = 130{,}000 + 16{,}250 + 20{,}000 = 166{,}250 \text{ foot-pounds.} \qquad (8)$$

As explained above

$$M_i = M_s \qquad (9)$$

or

$$Ce = M_s \text{ and transposing}$$

$$C = \frac{M_s}{e} = \text{the compressive stress in the boom.} \qquad (10)$$

Substituting the values in above formula

$$C = \frac{166{,}250}{5\frac{3}{4}} = 28{,}910 \text{ pounds.}$$

The unsupported length of the boom scales about 17 feet, and as in this case it is made up of two channels the load on each channel is $\frac{C}{2}$ or 14,455 pounds The inclination of the two channels towards each other need not be taken into consideration as the increase of load is very small. Consulting any handbook of information relating to structural steel we find that a 6-inch × 8-pound channel has a section area of 2.38 square inches and a radius of gyration with respect to an axis perpendicular to its web of 2.34 inches. Only this radius of gyration need be considered as the flanges of the two channels are latticed together. For the ratio of the length L of the boom in feet to the radius of gyration r in inches

$$\frac{L}{r} = \frac{17}{2.34} = 7.2,$$

which is not excessive. The elastic limit for soft steel may be taken at 30,000 pounds per square inch. Dividing the

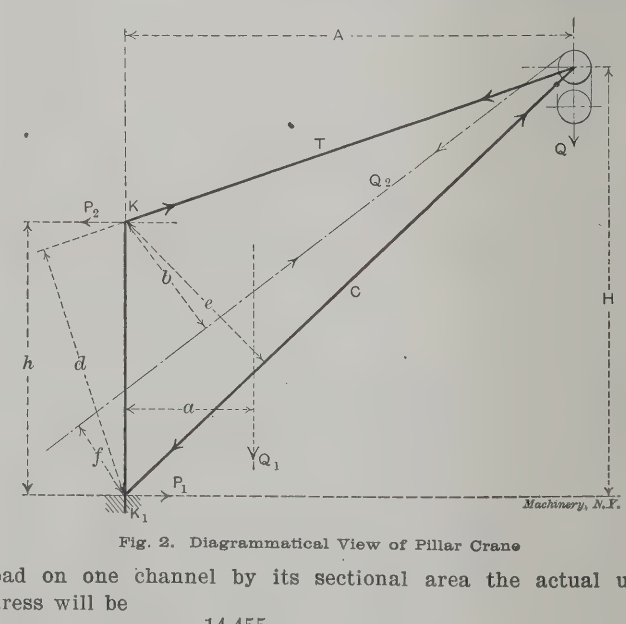

Fig. 2. Diagrammatical View of Pillar Crane

load on one channel by its sectional area the actual unit stress will be

$$\frac{14{,}455}{2.38} = 6{,}075 \text{ pounds,}$$

which shows that two 6-inch × 8-pound channels are quite sufficient to stand the load.

Stresses in the Tie-bars

To find the tensile stress in the tie-bars the same method as just explained will be used. Taking K_1 as a center of

* For previous articles on cranes, crane design, and efficiency of crane mechanism, see MACHINERY, January, 1909, engineering edition: Design and Construction of Electric Over-head Cranes, and also the articles there referred to; see also MACHINERY'S Reference Series No. 23, Crane Design.

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moments and referring again to Fig. 2, the moments of the external forces are:

Moment of $Q = M = QA$, (5)

Moment of $Q_1 = M_1 = Q_1 a$, (6)

Moment of $Q_2 = M_2 = -Q_2 f$. (11)

Dimension f is found by scaling to be 2½ feet.

Substituting the values in these formulas:

$M = 10,000 \times 13 = 130,000$ foot-pounds,

$M_1 = 5,000 \times 3\frac{1}{4} = 16,250$ foot-pounds,

$M_2 = -5,000 \times 2\frac{1}{2} = -12,500$ foot-pounds.

and the sum M_s of these moments is

$$M_s = 130,000 + 16,250 - 12,500 = 133,750 \text{ foot-pounds.} \quad (12)$$

The moment M_i of the internal stress T in the tie-bar is

$$M_i = Td. \quad (13)$$

Dimension d scales 7½ feet.

Since M_i must be equal to M_s

$$Td = M_s \quad (14)$$

and transposing:

$$T = \frac{M_s}{d} \quad (15)$$

Substituting the values in formula (15) the tensile stress in the tie-bars is: $T = \frac{133,750}{7\frac{1}{2}} = 17,830$ pounds.

As there are two tie-bars the load on one is $\frac{17,830}{2} = 8,915$ pounds. Using a safe fiber stress of 10,000 pounds per square inch, the area of one bar $= \frac{8,915}{10,000} = 0.892$ square inch with the corresponding diameter of 1 1/16 inch.

Stresses in Pillar

The stresses in the pillar are due to the bending moments of the loads Q and Q_1 and to the direct vertical loads Q and Q_1. The bending moment of Q and Q_1 was found by formulas (5) and (6) to be 130,000 foot-pounds and 16,250 foot-pounds, respectively. The sum of these moments is

$$M_s = M + M_1 = 130,000 + 16\,250 = 146,250 \text{ foot-pounds} \quad (16)$$

or 1,755,000 inch-pounds. This bending moment in inch-pounds must be equal to the product of the section modulus of the pillar cross-section, times the safe unit fiber stress. Considering the sectional area of a hollow cylinder for the cast iron pillar, the section modulus is

$$S = \frac{\pi (D^4 - d^4)}{32D} \quad (17)$$

in which D = the outside diameter of the pillar, and
d = the inside diameter of the pillar.

Using a safe fiber stress $s = 3,000$ pounds per square inch, the above mentioned equation reads:

$$M_s = \frac{\pi (D^4 - d^4)}{32D} \times s \quad (18)$$

Assuming an outside diameter of 24 inches, the inside diameter d is found by transposing the formula (18):

$$d = \sqrt[4]{D^4 - \frac{32\, M_s\, D}{s\, \pi}} \quad (19)$$

and substituting the values:

$$d = \sqrt[4]{24^4 - \frac{32 \times 1,755,000 \times 24}{3000 \times 3.14}} = 20\tfrac{7}{8} \text{ inches.}$$

As mentioned before, not only the bending moment, but also the direct vertical loads Q and Q_1 must be considered. As the bending moment produces a tensile stress on one side of the column and a compressive stress on the other side, the additional vertical loads Q and Q_1 naturally increase the compressive and reduce the tensile unit stress somewhat.

The unit stress in the pillar caused by the vertical loads is

$$s_1 = \frac{Q + Q_1}{\text{Area}} = \frac{15,000}{110} = 137 \text{ pounds per square inch.} \quad (20)$$

110 square inches is the sectional area of the pillar at the dangerous section.

The sectional area of the pillar was calculated for a bending stress of 3,000 pounds. Adding the unit stress for the bending moment and the unit stress for the vertical loads, the actual compressive unit stress is found to be:

$$3,000 + 137 = 3,137 \text{ pounds per square inch.} \quad (21)$$

Subtracting the unit-stress produced by the vertical loads from the unit bending stress the actual tensile stress s_t in the pillar results:

$$3,000 - 137 = 2,863 \text{ pounds per square inch.} \quad (22)$$

Vertical Tie-rods

The vertical tie-rods, connecting the crosshead with the lower end of the boom, receive the vertical component of the tensile stress T in the ties, and the vertical component of the compressive stress C in the boom, or what is the same, the added loads Q and Q_1.

$$Q_3 = Q + Q_1 = 15,000 \text{ pounds.} \quad (23)$$

in which Q_3 = the stress in the two vertical tie-bars.

Each of the two tie-rods receives half of this load or 7,500 pounds. Using a safe unit fiber stress of 10,000 pounds, the area of one tie-rod is $\frac{7,500}{10,000} = 0.75$ square inch, with a corresponding diameter of one inch.

Pintle

The reaction P_2 on the pintle (see Fig. 3) is caused by the loads Q and Q_1, whose moments about K must equal the moment of P_2 about the same center:

$$QA + Q_1 a = P_2 h = P_1 h \quad (24)$$

and this formula transposed and the values substituted

$$P_1 = P_2 = \frac{10,000 \times 13 + 5,000 \times 3\frac{1}{4}}{8} = 18,280 \text{ pounds} \quad (25)$$

The reaction P_2 produces a bending moment on the pintle, and referring to Fig. 3, this bending moment

$$M_b = \frac{P_2 L}{2} \quad (26)$$

in which L = the length of the pintle. Assuming the length $L = 1\frac{1}{2} D_1$, the formula (26) reads:

$$M_b = \frac{P_2 \times 1\frac{1}{2} D_1}{2}.$$

This moment has to be equal to the product of the section modulus of the sectional area of the pintle times the safe unit stress. The section modulus for a circular section being $\frac{\pi}{32} D_1^3$, and assuming the safe unit stress $s = 8,000$ pounds the equation reads:

$$\frac{P_2 \times 1\frac{1}{2} D_1}{2} = \frac{\pi}{32} D_1^3 s \quad (27)$$

and transposing

$$D_1 = \sqrt{\frac{P_2 \times 1\frac{1}{2} \times 32}{2\, \pi\, s}} \text{ or} \quad (28)$$

$$D_1 = \sqrt{\frac{18,280 \times 1\frac{1}{2} \times 32}{2 \times 3.14 \times 8000}} = 4\tfrac{1}{4} \text{ inches approx.}$$

and $L = 1\frac{1}{2} \times 4\frac{1}{4} = 6\frac{3}{8}$ inches.

Besides the bending moment produced by the reaction P_2 the direct vertical loads Q and Q_1 also produce stress, and this stress per square inch is found by dividing the sum of the vertical loads by the sectional area of the pintle in square inches:

$$s_1 = \frac{10,000 + 5,000}{14.19} = 1,060 \text{ pounds per square inch.} \quad (29)$$

The maximum unit stress on the pintle is then:

$$8,000 + 1,060 = 9,060 \text{ pounds per square inch.} \quad (30)$$

Foundation Bolts

Considering an axis A-A in Fig. 4, which shows a plan of the base of the pillar, the sum of the moments of the overturn-loads Q and Q_1 about this axis must be equal to the sum of the resisting moments. The latter are due to the stress in the foundation bolts and to the weight of the pillar. This weight can easily be calculated as the cross-section of the

pillar is already known, and in this case is found to be: $Q_4 = 5{,}000$ pounds. The moments of the overturning loads with respect to axis A-A are:

$$M_4 = Q\,(A - n) \qquad (31)$$

or

$$M_4 = 10{,}000\ \ (13 - 1\tfrac{1}{2}) = \ 115{,}000 \text{ foot-pounds},$$

$$M_5 = Q_1\,(a - n) \qquad (32)$$

$$M_5 = 5{,}000\ \ (3\tfrac{1}{4} - 1\tfrac{1}{2}) = 8{,}750 \text{ foot-pounds},$$

in which n = distance of the foundation bolts from the center of the crane. In this case n is found by scaling to equal 1½ foot.

The sum of the overturning moments =

$$M_4 + M_5 = 123{,}750 \text{ foot-pounds.}$$

The resisting moments of the foundation bolts are:

$$M_6 = 2P_3 n + (2P_3 \times 2n) \qquad (33)$$

in which P_3 equals the stress in one foundation bolt. The resisting moment of the weight Q_4 of the pillar is:

$$M_7 = Q_4 n = 7{,}500 \text{ foot-pounds.} \qquad (34)$$

The sum of the resisting moments is therefore equal to

$$M_4 + M_5 = 2P_3 n + (2P_3 \times 2n) + Q_4 n \qquad (35)$$

and transposing

$$P_3 = \frac{(M_4 + M_5) - M_7}{6n} \qquad (36)$$

Substituting the value s, the stress on one foundation bolt

$$P_3 = \frac{123{,}750 - 7{,}500}{6 \times 1\tfrac{1}{2}} = 12{,}910 \text{ pounds.}$$

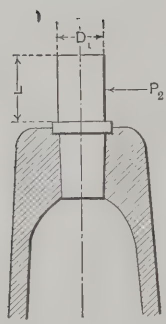

Fig. 3. Pintle of Pillar Crane

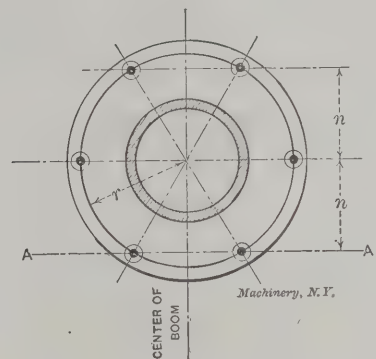

Fig 4. Layout of Arrangement of Flange Bolts

Using a safe unit stress of 12,000 pounds, the area of one bolt is $\dfrac{12{,}910}{12{,}000} = 1.08$ square inch with a corresponding diameter of 1¼ inch.

[The calculation of the foundation bolts as here given is correct only on the assumption that the base flange of the crane and the bolts are made of inelastic materials. For a more fundamental treatment of the subject of foundation bolts, see MACHINERY, December, 1906, engineering edition: Flange Bolts (reprinted in MACHINERY'S Reference Series No. 22). For an article on the Working Strength of Bolts, which should also be considered in this connection, see MACHINERY, November, 1906, engineering edition. (Also reprinted in Reference Series No. 22).—EDITOR.]

Foundation

Referring to Fig. 1, we find the moments which tend to overturn the crane with its foundation about an axis passing through e to be:

sum of overturning moments =

$$Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right) \qquad (37)$$

This sum of the overturning moments is resisted by the moment of the combined weights Q_5 of the foundation and the pillar:

$$\text{sum of resisting moments} = Q_5 \frac{D}{2} \qquad (38)$$

The equation of moments therefore reads:

$$Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right) = Q_5\,\frac{D}{2} \qquad (39)$$

and transposing

$$Q_5 = \frac{Q\left(A - \frac{D}{2}\right) + Q_1\left(a - \frac{D}{2}\right)}{\frac{D}{2}} \qquad (40)$$

assuming the diameter D of the foundation to be 9 feet and substituting the values:

$$Q_5 = \frac{10{,}000\ (13 - 4\tfrac{1}{2}) + 5{,}000\ (3\tfrac{1}{4} - 4\tfrac{1}{2})}{4\tfrac{1}{2}} = 17{,}500 \text{ pounds.}$$

Deducting from this combined weight of foundation and pillar the amount for the latter, we get the theoretical weight of the foundation:

$$17{,}500 - 5{,}000 = 12{,}500 \text{ pounds.}$$

Using a factor of safety of 3, the weight of the actual foundation must be:

$$12{,}500 \times 3 = 37{,}500 \text{ pounds.}$$

Having calculated the different parts of the crane as described it is good practice to test the pillar for its rigidity, as the amount of deflection must not be too great. The load on the unsupported end of the pillar was found by formula (25) to be $P_2 = 18{,}280$ pounds. The deflection N in inches is:

$$N = \frac{P_2 h^3}{3\,EI} \qquad (41)$$

in which

h = the height of the pillar in inches = 96 inches,

E = the modulus of elasticity = 12,000,000 for cast iron,

I = the moment of inertia $= \dfrac{\pi}{64}\,(D^4 - d^4) = 7{,}257$.

Substituting these values we find the deflection

$$N = \frac{18{,}280 \times 96^3}{3 \times 12{,}000{,}000 \times 7{,}257} = 0.062 \text{ inch,}$$

or about 1/16 of an inch, which is not excessive.

* * *

INTELLIGENT USE OF LABOR-SAVING MACHINERY

It is one thing to use labor-saving machinery in order to permit rapid production and to conserve the energies of workmen, so as to produce a better product with greater rapidity, and quite another thing to use labor-saving machinery simply to avoid work. In one case there is economy of production, while in the other case there is wastefulness of production. An illustration came to our attention not long ago in the building of a fence in City Hall Park, New York. This fence is made of one-inch heavy pipe, supported in suitable posts. To prevent it being made a roosting place by loafers "anti-sit-downs" were fastened to the top rail with one-quarter inch stove bolts. To drill these holes, a portable gas engine and electric motor were provided to drive an electric drill. The cost of the outfit and a suitable charge for its depreciation undoubtedly made the cost of drilling the holes considerably greater than it would have been had they been drilled by improved breast drills, with power feed and chain support. These useful little tools are capable of putting a hole through a one-inch pipe in a very short time, and the cost of equipment is very low. Labor-saving machinery should be something more than "labor-saving"; it should be production-increasing and economical as well.

* * *

When the De Laval steam turbine was first brought into the market, the units were small and there was no condensing, and the result was a high steam consumption. Subsequent improvements, however, have tended to reduce the steam consumption so materially that this type of steam turbine now claims a place among the most economical motors. In referring to the figures below it should be borne in mind that the steam consumption refers to effective horse-power, while in many cases it is customary to give the steam consumption per indicated horse-power. One 500 horse-power turbine installed at Stockport, Great Britain, shows a steam consumption per effective horse-power of 13½ pounds per hour; another of 330 horse-power installed in St. Petersburg, Russia, shows a consumption of 12½ pounds per hour.

LOCOMOTIVE REPAIR SHOP PRACTICE—2

THE C. M. & ST. P. R. R. SHOPS AT MILWAUKEE

ETHAN VIALL*

In this article, which is a continuation of the one published in the August number, the practice in the tool-room, boiler, and blacksmith shops will be specifically treated, and in addition descriptions of the tools and methods employed in connection with other branches of locomotive repair work will be given.

In the tool-room, which is in charge of Gust. Gstoettner, everything is neat and up-to-date as is evident by the illustration, Fig. 38, which shows the arrangement of the gear and milling cutter rack which is a model for any shop. Flue expander segments are all made in the tool-room, and the special mandrels used to hold the segments while they are being turned, are shown at *A*, Fig. 39; some of the unturned segments are shown at the right. At *B* is shown the way the segments are held together while being placed on the man-

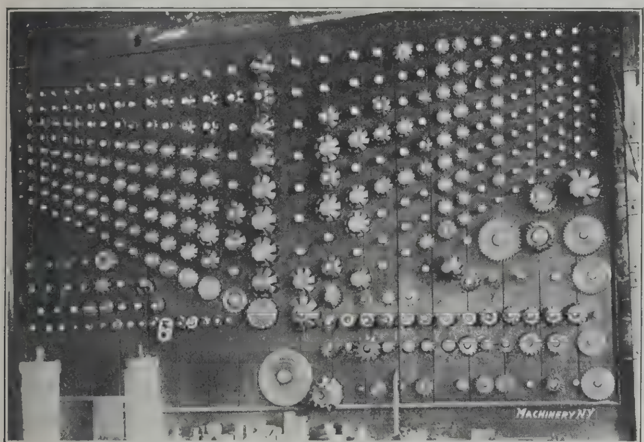

Fig. 38. Gear and Milling Cutter Rack in the Tool-room

drel. The clamping collar shown is removed as soon as the mandrel nut is tightened enough to hold the parts securely. At *C* are shown three sets of finished segments held together by heavy rubber collars until wanted for use. The steel from which these segments are made is bought already drawn to the right sectional shape. It is then cut up into the right lengths and the ends, beveled sides and narrow edge ground on the grinder shown in Fig. 40. A special clamping device, *A*, holds the parts while the ends are being ground and another clamp *B* holds them while the narrow edge is ground. The device used to hold them while grinding the bevel, is out of sight behind the wheel.

Boiler Shop Kinks

In the boiler shop the common pneumatic flue swage used in most railroad shops, has a rapid-stroke pneumatic welding swage or die, placed on one side as shown at *A* and *B*, Fig.

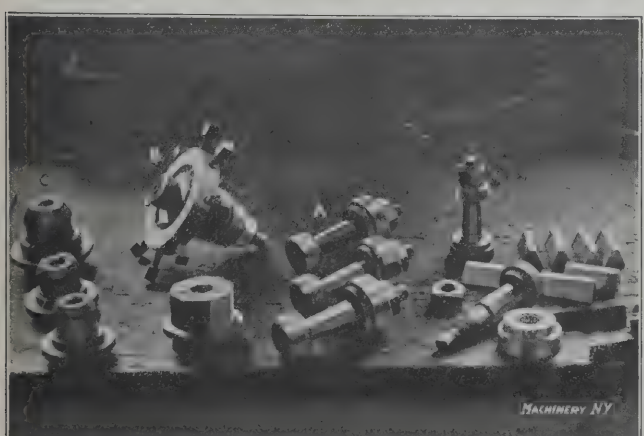

Fig. 39. Flue Expander Segments and Tools used in making them

43. After a new end has been placed on the flue and welding heat taken, it is placed in this die and the air turned on by means of the hand lever shown. The rapid blows complete the job in a hurry, and apparently do it just as well as the usual rolling device used for welding.

* Associate Editor of MACHINERY.

Ends of flues are cut off in the pneumatic trimmer, Fig. 41, and repair ends are cut off and one end beveled in the ma-

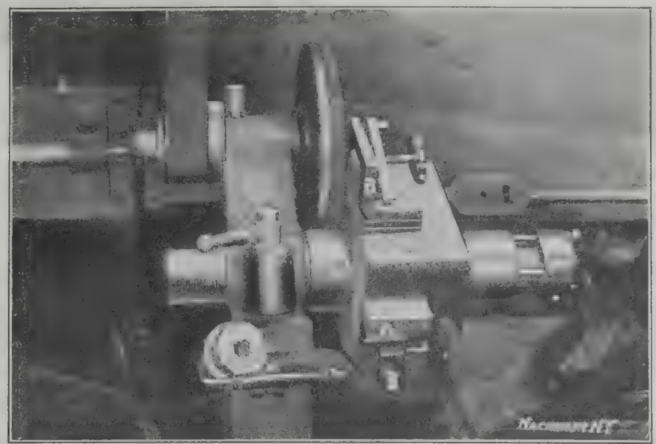

Fig. 40. Special Grinder for Flue Expander Segments

chine shown in Fig. 44. This machine has a two-jawed pneumatic chuck *A*, for holding the flue which is being cut into short pieces. The principle of the operation of this machine can be understood by examining this and the following engraving. The bevel on one end of the pieces is obtained by using a wide cut-off tool straight on one side and beveled at about 45 degrees on the other.

Fig. 45 is the same machine with a taper reamer placed in the pneumatic chuck *A*, for the purpose of beveling and removing the burr from the inside of the short piece of flue held by the hand clamping levers *C* and *D*. A large number of flue end repair pieces can be cut off and one end reamed in this machine in a very short time.

Assembling Springs

In the spring department of the blacksmith shop, springs are assembled and compressed ready for the band by the

Fig. 41. Pneumatic Flue-cutter

clamps shown in Fig. 46. After the hot band has been slipped into place, the clamp is removed and the band and spring compressed in the steam bulldozer shown in Fig. 47. While the pressure is on, the sides of the band are hammered down closely onto the spring with sledges. Pressure is kept on the band until it is cool enough to hold the spring leaves firmly together.

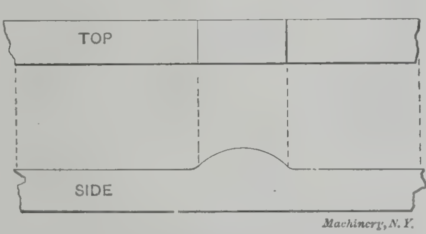

Fig. 42. The Way a Bar is upset in the Middle by a Bulldozer

Scrap metal is "baled" and then welded and forged into billets or slabs and then a number of these slabs are welded together, and forged into various locomotive parts. Fig. 48 shows nine of these slabs ready to be heated, welded and forged into a driving-axle under one of the big steam hammers.

Special Bulldozer Formers

Charles G. Juneau, who has charge of the blacksmith shop of the new car department, has some very unusual bulldozer forging and bending forms. The first piece of work here shown is really a forging job, but Mr. Juneau has contrived to do it in good shape on a bulldozer. The operation consists in upsetting the metal at the middle of a bar of iron which is afterward bent into a U-shape, the object being to give the piece more strength at the bend than would otherwise be the case, and allow for the stretching of the metal on the outside at this point. Fig. 42 shows the manner in which the bar is upset and shaped at the middle, and Fig. 49 shows how it is done, the piece in this case being intended for an axle hanger. To start with, the bar is heated at the middle for seven or eight inches; then it is placed in the machine and formed at one stroke by the ram shoving the bar against the stop *A*, which upsets it, after which the arm *B* wedges die *C* over against the other half *D*, completing the shape.

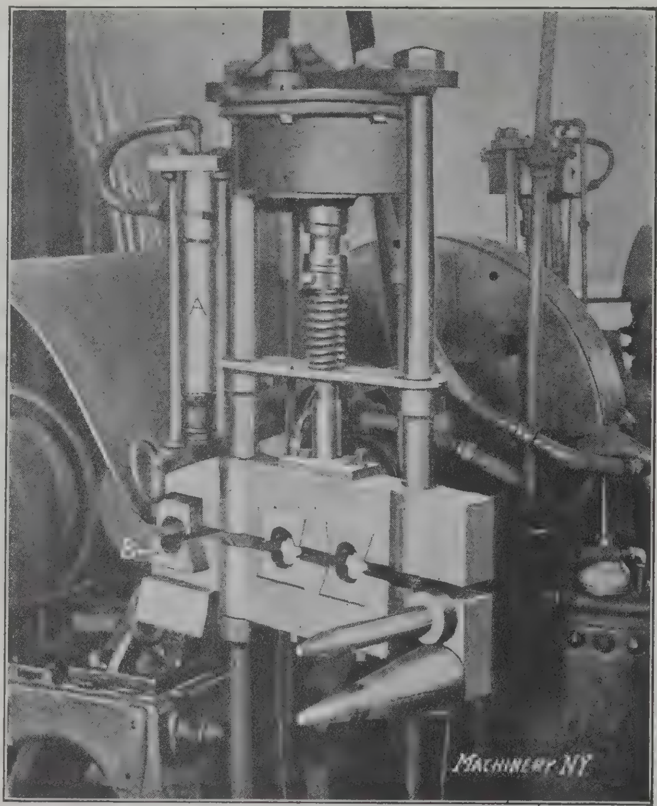

Fig. 43. Pneumatic Flue-swage and Welding Die

The bars used for swing hangers, are upset in the same way, and are then bent as shown in Fig. 50, the bar being shown at *F* just as the former is starting to bend it, and at *G* is shown the way it looks at the end of the stroke. The partially made swing hanger is now placed in the former shown in Fig. 51. This engraving shows the part with one end bent around and the forming ram in position for the bending of the other end. On the first stroke in this bender the end that is farthest from the ram, is bent up far enough to be out of the way as the other end is bent around. As the metal is red hot, this bending up of the one end is easily done and as easily tapped back into place with a hammer, before placing it on the form for the final bend. The construction of this former is too clearly shown to need explanation, except that the part of the end of the forming ram, that is under the guard plate, is of practically the same shape as the part that shows, a roller being used on the contact parts of both sides of the end. The coiled spring is, of course, to keep the ram against the forming guide during the entire stroke. After the ends are bent to place, they are welded in the dies shown in Fig. 52, which are also used in a bulldozer.

Cylinder carrier brackets are cut to length, drilled and then shaped on the former, Fig. 54. A finished bracket is shown leaning against the end of the truck on which the former is placed. The bracket is located correctly in the bending form, by means of a hole drilled in the middle of the bar into which a pin in the form, operated by the small hand lever *A*, is inserted.

Eye-bolts are formed at one stroke, in the former shown in

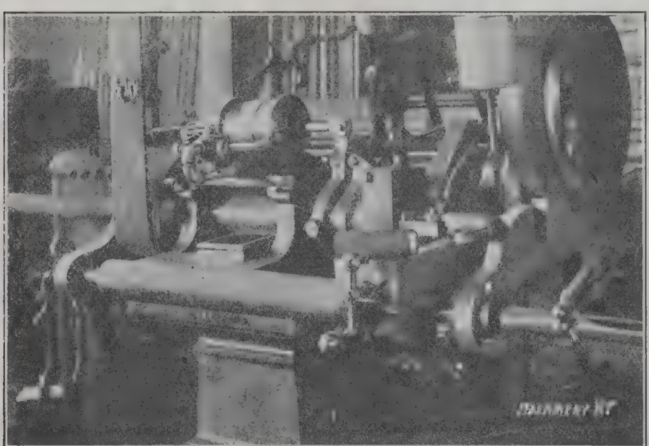
Fig. 44 Machine for Cutting and Beveling Flue Repair Ends

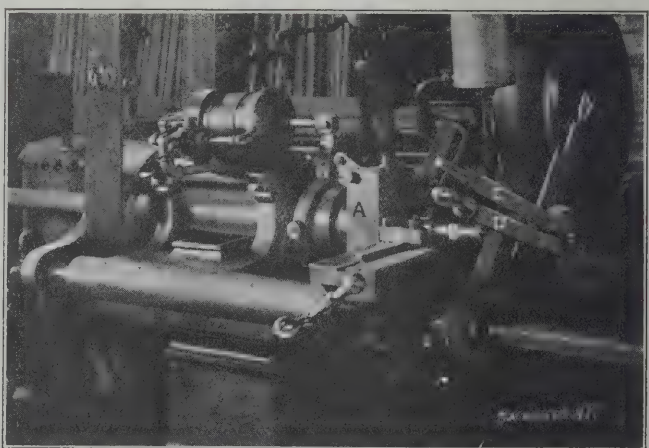

Fig. 45. Reaming out the Flue Repair Ends


Fig. 46. Compressing a Locomotive Spring before the Band is put in Place

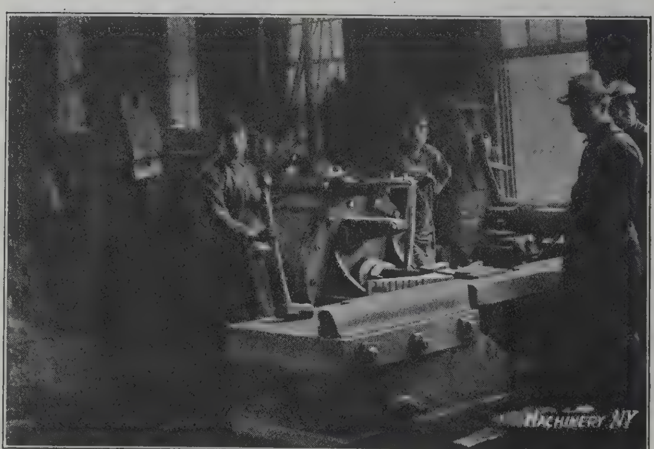

Fig. 47. Compressing Spring Bands in a Steam Bulldozer

Fig. 48. Steel Slabs to be welded and forged into a Driving Axle

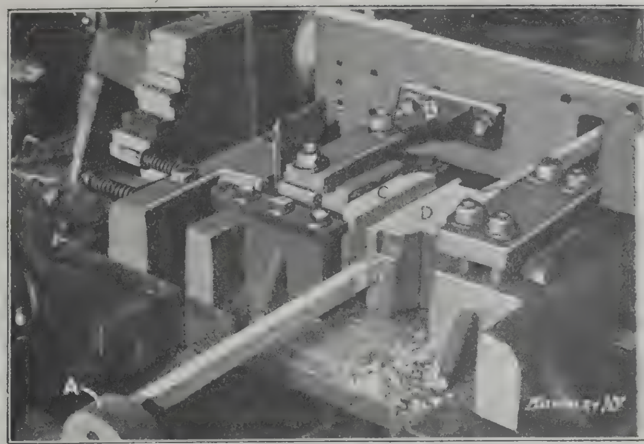

Fig. 49. Bulldozer for Upsetting a Bar, as indicated in Fig. 42

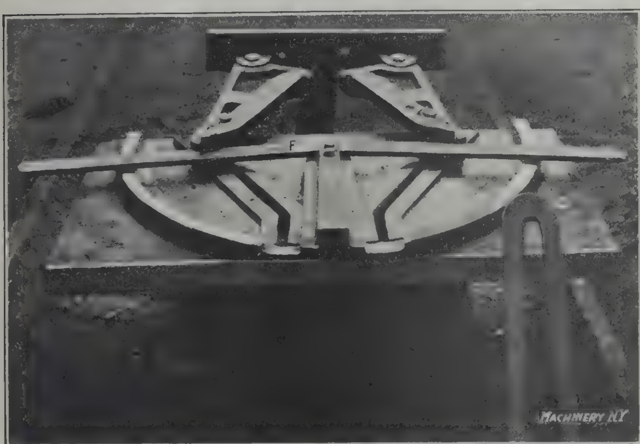

Fig. 50. Former for Making Swing-hangers

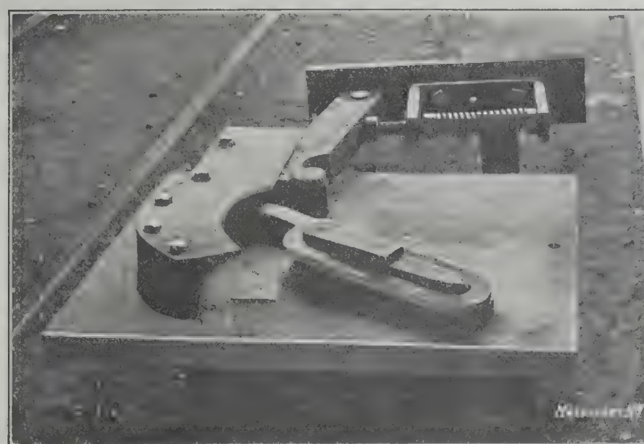

Fig. 51. Completing the Bending Operation on a Swing-hanger

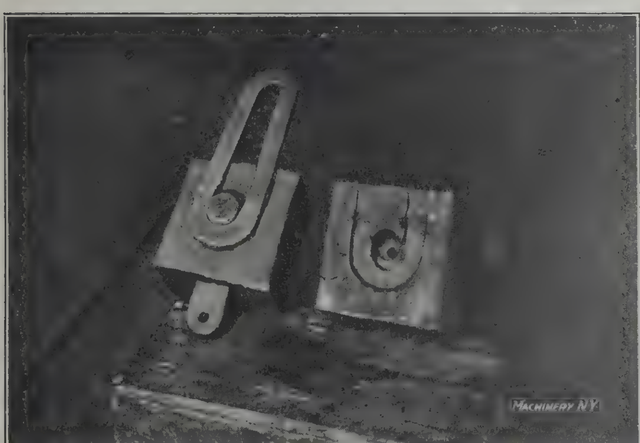

Fig. 52. Die used in Welding the Ends of Swing-hangers

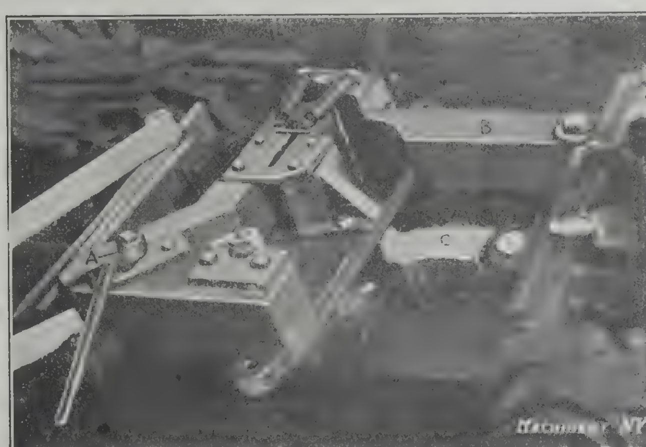

Fig. 53. Machine for Forming Hinges

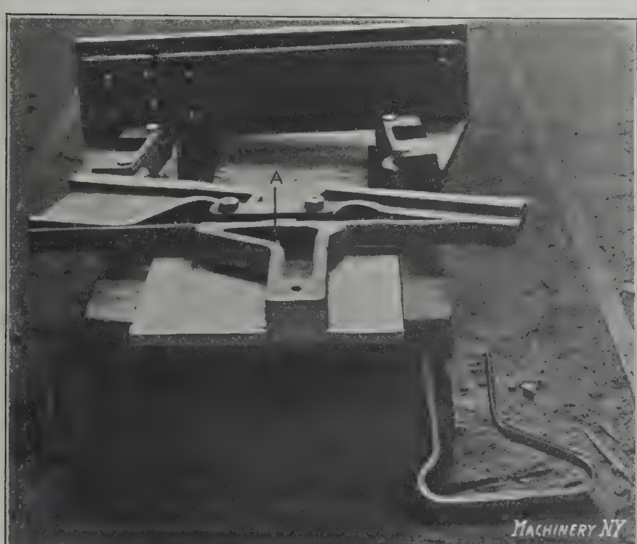

Fig. 54. Forming a Cylinder Carrier Bracket

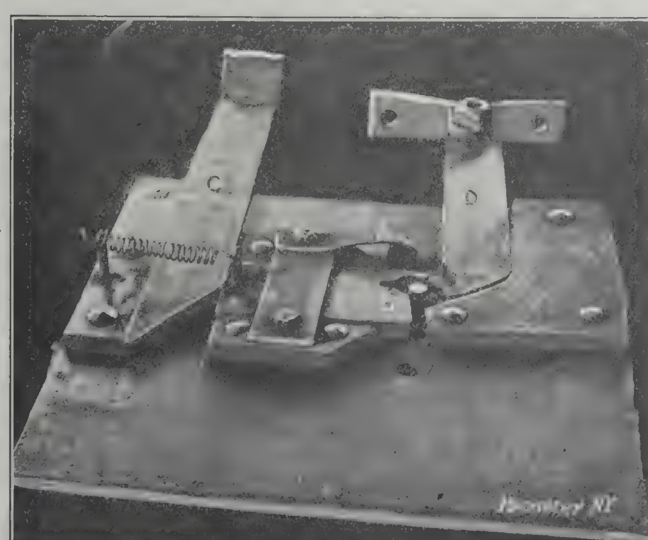

Fig. 55. An I-bolt Former

Fig. 55. The rod from which the eye-bolt is to be made, is heated and thrust in against the stop *A*, and on the stroke of the bulldozer ram, the part *C* being longest, pushes or wedges the part *B* over, forming a part of the eye. Part *D* next strikes the projecting end of the rod, bends it part way around and then coming in contact with the bevel, shoves it over, completing the eye. The recess *B* is intended to be used when connecting a chain to the eye-bolt, the end link of the chain being slipped into the recess and the end of the rod passed through it and bent as usual.

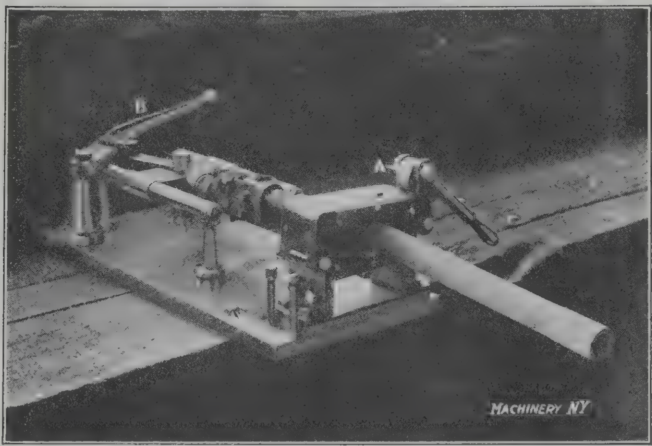

Fig. 56. Tool for Pressing Air Hose Couplings into Place

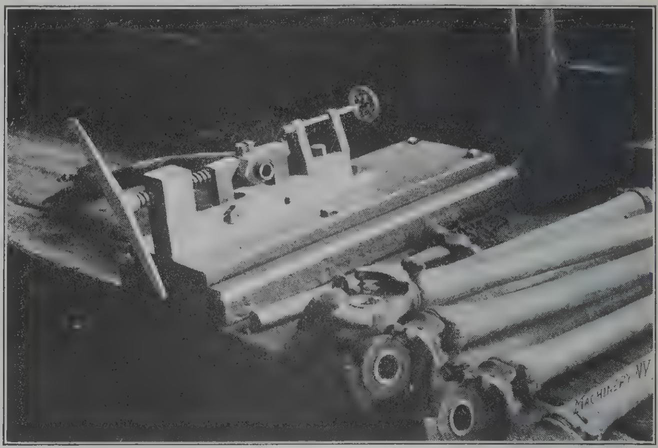

Fig. 57. Tool for Compressing Air Hose Clamp Collars

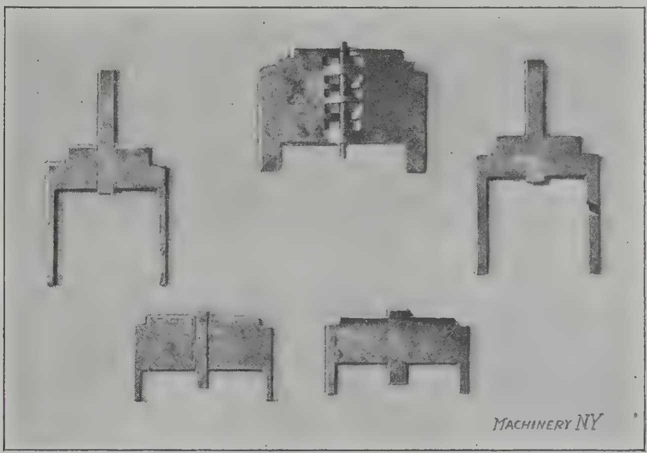

Fig. 58. Air Valve Lift Gages

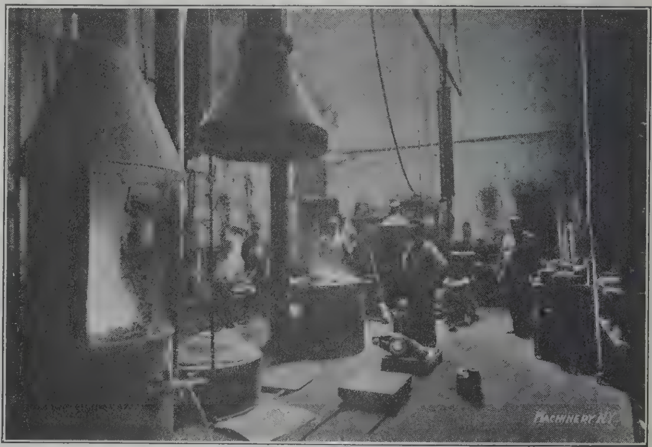

Fig. 59. The Babbitting Room

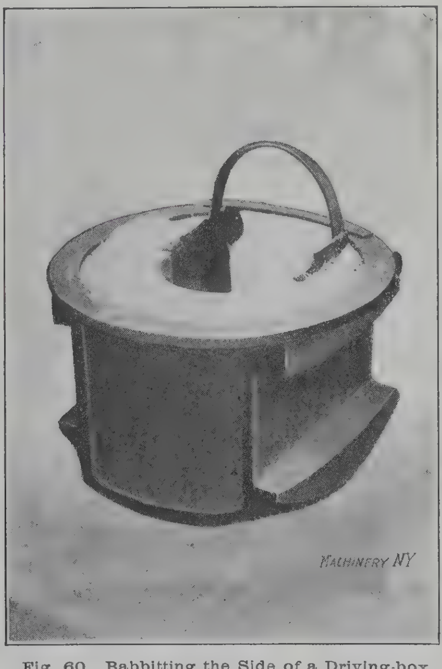

Fig. 60. Babbitting the Side of a Driving-box to Compensate for Wear

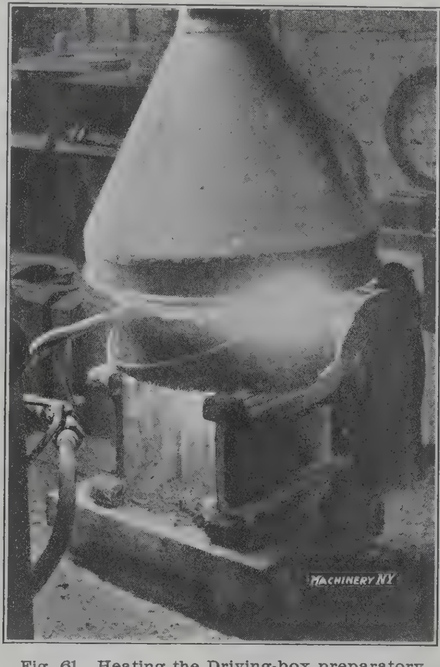

Fig. 61. Heating the Driving-box preparatory to Babbitting

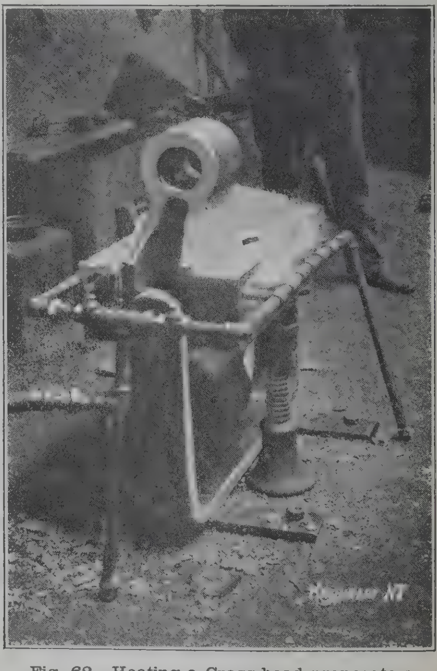

Fig. 62. Heating a Cross-head preparatory to Babbitting

Fig. 53 shows how hinges are made, which is very similar to the forming of an eye-bolt. The bar heated on the end, is placed in the former and locked by the eccentric hand lever *A*. On the stroke of the ram the hinged piece *B* shoves the cross-slide over, pushing the end of the bar around the form pin far enough for the part *C* to catch it and complete the bend, the final motion of the part *C* being exactly the same as that of the corresponding piece on the eye-bolt bender.

Repairing Air-brake Couplings

Air-hose couplings are forced into the ends of the new hose lengths in the little device shown in Fig. 56. The hose is held and locked by the eccentric lever *A* and the coupling is shoved into place by pulling on the lever *B*. The locking collars are compressed, while the bolt and nut are put in place and tightened, in the clamping device shown in Fig. 57.

The gages used to measure the amount to take off of the

plugs in a Westinghouse air pump, in order to allow the proper valve lift, are shown in Fig. 58. These gages are of a simpler form, but made on the same principle, as those shown in Fig. 33 (page 662), of the May number. The movable slide in the center is made of such a length, that when the shouldered end is placed in the plug opening and the center piece pushed down on top of the valve, the distance from the other end of the slide, to the ends of the fork, indicates the length the plug should be from its shoulder to its end, in order to allow the valve to lift just right. Friction alone is depended upon to hold the slide of the gage in whatever position it is set.

Babbitting Jigs

The babbitting room, Fig. 59, is a very complete little department all by itself, but under the general supervision of the machine shop foreman. Fig. 60 shows the way the sides of the driving-boxes are faced with babbitt. A special ring is laid on the box, and two pieces held in place by a loop spring, completes the "mold." Babbitt is then poured into this mold and the job is done. Before using this mold, however, the box must be heated and tinned on the side in order to make the babbitt stick properly. The heating is done as shown in Fig. 61. The driving-box is placed on a little four-wheeled iron truck and run under a big hood. A pan containing burning coke is then set on top and the heat forced down onto the side of the box by an air blast as shown. After being sufficiently heated, the coke pan is removed, the truck pushed along a short distance, and the end of the box tinned with solder and the babbitt put on as already shown.

Fig. 62 shows the heater used to heat crossheads previous to putting on the babbitt liners. These liners are molded by clamping an iron band around the edge of the surface to be babbitted, which has been previously tinned, the whole process being similar to the way the driving-boxes are babbitted.

Metallic packing is made in a department in charge of Mr. Edwards, who has been with the company nearly forty years and has patented a number of things now in common use on railroads. Fig. 63 shows a set of Edwards piston-rod packing rings, and the three molds used to produce them. Another set of packing molds and a sprue cutter are shown in Fig. 64.

Fig. 63. Metallic Packing for Piston-rods and Molds in which it is cast

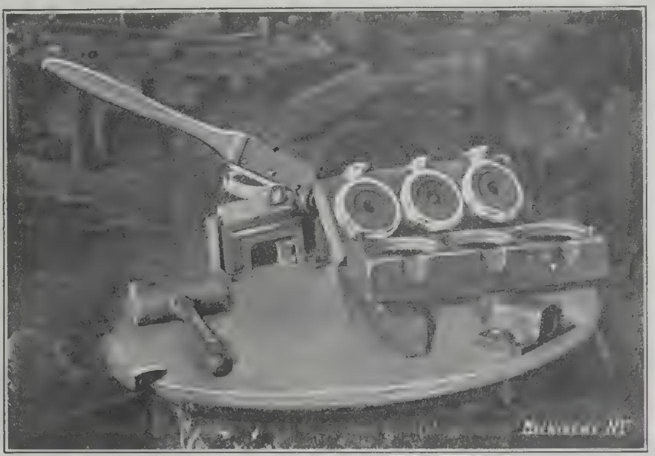

Fig. 64. Other Packing Molds and a Sprue Cutter

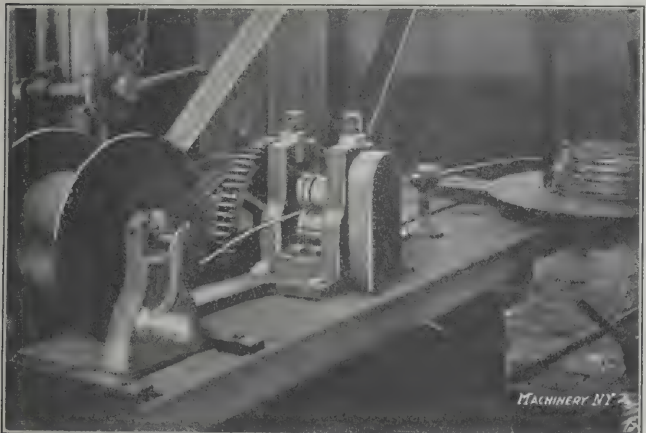

Fig. 65. Rolls for Flattening and Sizing Copper Wire for Gaskets

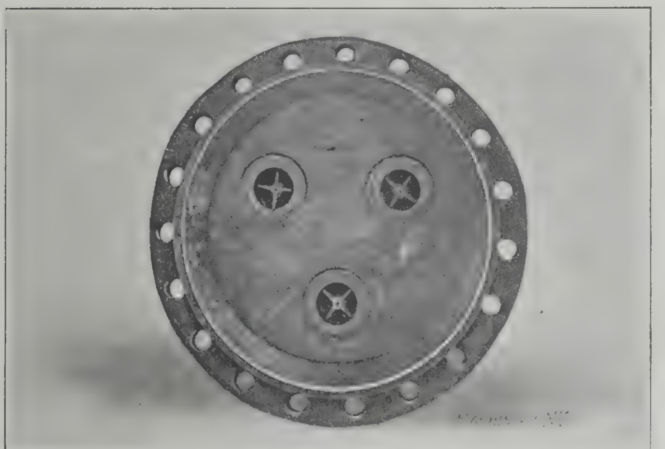

Fig. 66. A Dome Cover with Copper Wire Gasket in Place

Wire Gasket Practice

Considerable difference of opinion exists in various railroad shops as to the best method of making or applying copper wire gaskets for dome covers and steam chests, some lapping and brazing the ends and others just butting them together. Mr. Edwards' method is to first run the wire through flattening rolls, Fig. 65, in order to give it a uniform thickness, and then to force the wire edgewise into a groove cut for the purpose. Fig. 66 shows a dome cover in which a gasket has been inserted in this way. The ends of the gasket are beveled to about 45 degrees and are fitted closely together in the groove, but not brazed or soldered in any way.

* * *

PURE AIR LAW FOR WORKMEN

C. M. RIPLEY*

The new labor law requiring a supply of fresh air for employes of work-shops and factories, reads as follows: "The owner, agent or lessee of a factory shall provide, in each workroom thereof, proper and sufficient ventilation; if excessive heat be created or if steam, gases, vapors, dust or other impurities that may be injurious to health be generated in the course of the manufacturing process carried on therein, the rooms must be ventilated in such a manner as to render them harmless, so far as is practicable."

Mr. William W. Walling, chief factory inspector for the state of New York, interprets the law as follows:

"As defined by Dr. John S. Billings, perfect ventilation means that any and every person in a room takes into his lungs at each respiration, air of the same composition as that surrounding the building, no part of which has recently been in his own lungs or those of his neighbors, or which consists of the products of combustion generated in the building, while at the same time he feels no currents or drafts of air, and is perfectly comfortable as regards temperature, being neither too hot nor too cold. How much air is required to meet these conditions? Not less than 2,000 cubic feet per hour for each person, with the same amount per hour for each cubic foot of gas consumed whether for light, heat or power."

* Address: 45 W. 34th St., New York City.

Is this Amount Arbitrary?

Some landlords in New York City have put forth the claim that the amount of fresh air specified by the Department of Labor is an "arbitrary quantity." Several authorities on the subject of ventilation who have been consulted in the matter and who are also entirely disinterested agree that 2,000 cubic feet per hour per person is common practice and is based upon definite laws or rules which have been followed for many years in the design of ventilating systems.

The Architects' and Builders' Pocketbook, compiled by Mr. Frank E. Kidder, states that 1,800 cubic feet per hour per child should be the standard for school buildings, this amount being required by law both in Massachusetts and New York. It further states that in buildings more closely packed, and occupied for a longer period, the air supply should be from 2,000 to 2,500 cubic feet per hour per person. In giving an example of a school-room of certain dimensions, he shows that the standard amount of air would result in the air in the room being changed about eight times per hour, which certainly does not appear to be an excessive amount.

Since the above applies only to buildings where people sit quietly, or for buildings where only children congregate, it is difficult to see how the New York Department of Labor can justly be accused of an "arbitrary" action.

Mr. Percival Robert Foses, consulting, heating and ventilating engineer of New York City, states that he has found the rate of 2,000 cubic feet per hour per person a satisfactory and conservative working basis. This was used in designing the ventilating equipment of the large department store of B. Altman & Co., in the Rikers Island Penitentiary, in the Baltimore Stock Exchange, and in the new Hearst Building at San Francisco, as well as in others; and he stated that the operating expense for a system laid out on this basis has not been found excessive, and will not be if due care is taken at the time of installation.

Example of a Loft Building

In a loft 25 feet wide and 100 feet long, containing 80 workmen, and lighted with electricity, the amount of air required would be 80 times $2{,}000 = 160{,}000$ cubic feet per hour. This amount of air per hour would move at the rate of about ⅛ mile per hour, and would be sufficient to change the air in the loft six times per hour, assuming a ten-foot ceiling. Since the Massachusetts and New York State laws for school rooms require eight changes per hour and since some authorities recommend even 50 per cent in excess of this, it appears that the action of the factory inspector hardly comes within the definition of the word "arbitrary."

Gas Lighting

Dr. Daniel R. Lucas of New York City states that it is a well-known law of hygiene that one gas jet will consume as much oxygen as five persons. Since electric lighting, thanks to the new high efficiency lamps, has been reduced in cost 50 per cent or more, it appears that the easiest way to comply with the labor law regarding ventilation would be to abandon gas lighting. In New York City especially this would seem advisable, as electricity can be bought by meter from the street or from the power plant downstairs.

Since the vitiating effect on the air of the average gas light is equivalent to that of five persons, it can be readily seen that the ventilation required will be reduced 5/6 by abandoning gas light, assuming one gas jet to each workman, or, stating it in another way, the landlord who clings to gas lighting must install ventilating apparatus six times as large as would be necessary if electric light were used. This calculation is also based upon conditions where one gas jet is provided for each workman.

Operating Costs

The operating cost for a ventilating system is made up of two items: (1) Power for turning fans; (2) Additional heat for incoming air. In a loft building where the tenant will pay for the power, and the landlord will pay for the extra heat required, since heat is included in the rent, the expense will be divided automatically. It will here be noticed that the adoption of electric lighting will cut down the operating expenses to a remarkable degree. This cut in expense will benefit the tenant, since a much smaller ventilating motor will be required, and it will also benefit the landlord because less air will have to be drawn in, and hence the cost for heating will be diminished.

In large systems the services of an expert heating and ventilating engineer would probably prove valuable, and it is possible to so design the equipment that a judicious "recirculation" of the air from halls and basements will effect an economy in the fuel bill. This air is seldom impure and requires much less heat than if cold air were brought in from outside. It is also possible in buildings where high pressure steam is available, or where boilers which have been run at low pressure steam can be run at a high pressure, to adopt the following policy: Provide steam engines to operate the fans and turn the exhaust steam into the heating coils, thus getting a double use out of the steam and cutting down the electricity bill. This idea could be carried still further in many instances, and economies could be made (especially in the winter) by abandoning electric pumping, and again reducing the expense for electricity. This is the stock argument of the advocates of isolated plants, who contend that great economies result in buildings of a million cubic feet or more, if engines are installed and electricity is made on the premises. It is a fact that steam at high pressure contains only about 6 per cent more heat than steam at low pressure. Thus the argument that electricity can be made and a building heated with exhaust steam, is advanced. The layman does not appreciate one very peculiar fact about steam: that at 5 pounds pressure it is only about 6 per cent cheaper to make than at 100 pounds pressure, showing that the cost does not increase in proportion to the pressure.

In the future it is probable that factories and loft buildings will be equipped with ventilating apparatus at the outset, with the ducts concealed in the walls and the fans located in the basement. A model building of this character has recently been completed at 37-43 West 26th St., New York City, in which the landlord at the time of construction had the ventilating system installed at his expense, after the design of a prominent consulting engineer. Thus the cost of operating a system and the responsibility of maintaining it in good condition does not rest upon the tenant. At the present writing (June 17) we are informed that the owners of the West 26th St. corporation, with offices at 725 Broadway, have already rented eight out of the twelve floors, a flattering reception and appreciation of the advantages they have to offer.

Importance of Pure Air in the Industries

In the report of the United States Bureau of Labor at Washington, D. C., it is shown that deaths among factory workers due to consumption were divided as follows:

Employes exposed to metallic dust	36.9 per cent
Employes exposed to mineral dust	28.6 per cent
Employes exposed to vegetable fiber dust	24.8 per cent
Employes exposed to animal and fiber dust	32.1 per cent

It was also shown that the highest consumption mortality existed among operators of grinders, and 49.2 per cent of all deaths were from that disease.

An ingenious conclusion was reached by Mr. Frederick L. Hoffman of the Prudential Life Insurance Co., based on this report. It is his opinion that by intelligent methods of ventilation and dust removal the consumption death rate among the wage earners could be so reduced as to result in an annual saving of 22,238 lives. This would add, quoting the *Engineering News*, "15.4 years of life for every death from consumption avoided by rational conditions of industrial life." Such a gain would represent a total of 342,465 years of additional life, and by just so much the industrial efficiency of the American nation would be increased. Placing the economic value of a year's life time at only $200, the total average gain to the nation would be $3,080 for every avoidable death of a wage earner from consumption, representing the enormous total of $68,493,000 as the annual financial value clearly within the range of practical attainment. Therefore, nothing within reason should be left undone as a national, state, individual, or social duty to prevent that needless but now enormous loss of human life from consumption due to the unfavorable conditions in American industry.

MAKING SOLDERLESS CANS FOR FOOD PRODUCTS

RALPH E. FLANDERS*

For a number of years, in riding out of New York on the "Shore Line," the writer has noticed on the right-hand side of the track, shortly after leaving Mt. Vernon station, an unusually neat and attractive group of shop buildings. The sign on the roof of the main building reads "Max Ams Machine Co." with some supplementary reference, which escapes the memory at the moment, relating to a process of manufacturing a sanitary, solderless can. While he has seen this

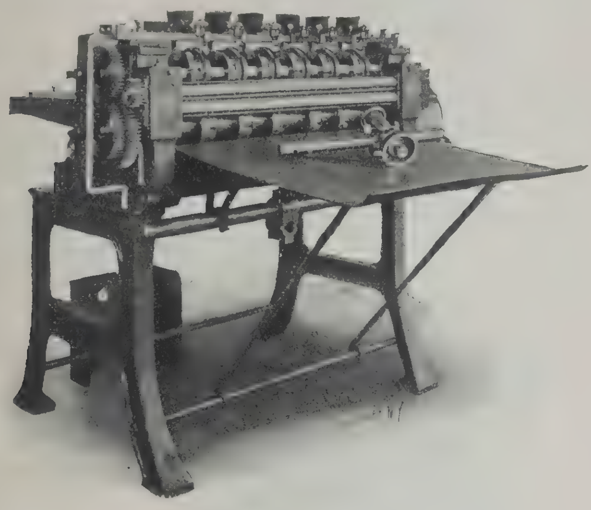

Fig. 1. Slitting Rolls with Double Cutting Edges and Self-contained Grinding Attachment

sign for several years, and has always felt a twinge of curiosity at each passage, it was only within the past few weeks that he embraced the opportunity to become acquainted with the men who are working at this place and with the work which they are doing.

The product of the shop and the methods of manufacture were found to be fully as interesting as the exterior gave promise of. Besides the line of work indicated by the sign, which now forms but a small part of the firm's output, the shop was found to be building a general line of tools for sheet metal working. There was evidently also a lot of contract work of various kinds going through the shop, both special machinery and tools, and it was evident that the mechanics here stand ready to tackle any job in sight in the line of small and medium metal working, taking particular pleasure in undertaking stubborn problems that have long resisted solution.

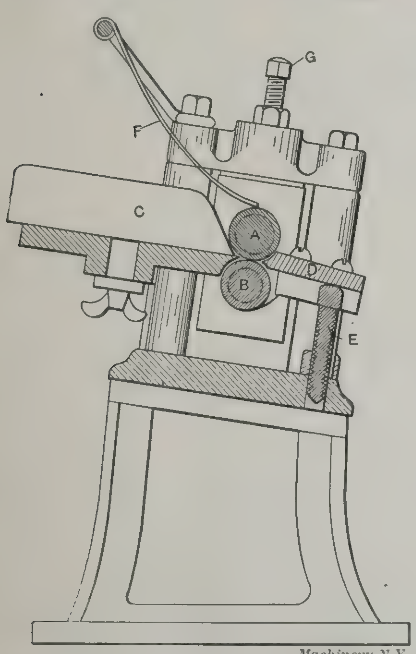

Fig. 2. Two-roll Bending Machine with Simple Adjustment for Radius of Curvature

The Ams Sanitary Can

But to get back to the sanitary cans. While this is now but a small portion of their work, it is a most interesting one, and with the permission of Mr. Ams some of the methods and machinery employed by this process are here illustrated and described. This system undertakes to make a can hermetically tight without the use of solder, brazing of any sort, or heat, the process being a cold one. This statement refers strictly to the sealing of the top and bottom of the can. The side seam is a new lock-seam which prevents any solder from the outside of the can body entering the interior of the can. The inside of the can is absolutely free from solder or acid, and a process which does not employ acids or other fluxes, or solder of any kind, has immense advantages from the sanitary standpoint.

Making the Body of the Can

The making of the body of the can will first be described. This does not differ materially from the process usually followed. Sheets of tinplate are first run through slitting rolls, such as shown in Fig. 1, and cut into strips of the proper width for the body of the can to be made. After thus being passed through lengthwise, the adjustment of the rolls may be altered, and the strips passed through again crosswise, thus cutting them into blanks of the size required.

Two or three improvements in the construction of these slitting rolls may be noticed. In the first place the cutters themselves are provided with cutting edges on both sides. This is an advantage oftentimes in setting them for work on narrow strips; and giving two edges in place of one doubles the life of the cutters as well. The principal improvement in the construction, however, relates to the sharpening of the cutting disks, which is done while they are in place in the machine. The attachment for performing the operation is seen on the receiving table in the illustration. It is a cup emery wheel, driven by a belt from an overhead drum and mounted on the swiveling holder seen on the bar beneath the

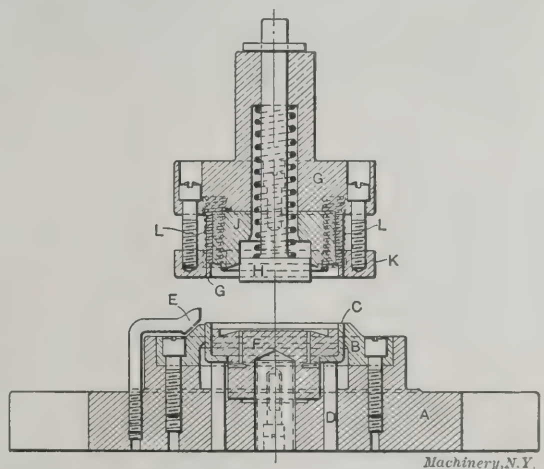

Fig. 3. Compound Punch and Die for Turning Can Cover shown in Fig. 4

table. By swinging this table down out of the way and dropping the delivery rolls, the disk cutters are exposed to the action of the emery wheel and the sharpening can be proceeded with expeditiously and effectively.

After thus cutting the blanks to the proper dimensions, they are bent into cylindrical form by the rolling machine, shown in Fig. 2. This has but two rolls in place of the three often used for such work. The blank is fed from the table *C* between rolls *A* and *B*. After passing through, the edge passes the guide plate *D* and is by it turned up about roll *A*. The radius of the curvature thus produced is regulated by adjusting screw *E*, which rocks guide plate *D* about the axis of roll *B*. This machine takes the blanks as fast as a dexterous operator can feed them between the rolls.

The soldering of the side seam may be done by hand with special fixtures, or on any of the commercial machines provided for the purpose. The makers have developed an automatic machine for this work in which the cylindrical sheets are placed by hand on a series of forms, which are indexed about a vertical spindle. As they are being pressed on the forms the edges pass under brushes which lay on the acid flux. The next indexing of the spindle brings the work to the soldering iron, where strips of solder are laid along the seam, being cut off and smoothed on by a mechanically operated iron, heated by gas. In the third position the work is allowed to cool, and in the fourth it is removed from the form, leaving it ready for the next piece.

* Associate Editor of MACHINERY.

The final operation on the body of the can is that of flanging to the form shown in the sketch at *A* in Fig. 4. This flanging is done in a simple and obvious way by inserting the work in rolls, which rotate it and turn up the edge as it revolves.

Making the Covers

The can covers are blanked and formed from the sheet in a single operation by a double action die, shown in Fig. 3; the shape given to them is indicated in the upper left-hand corner in Fig. 4. A sheet is laid in the die against stop *E* in

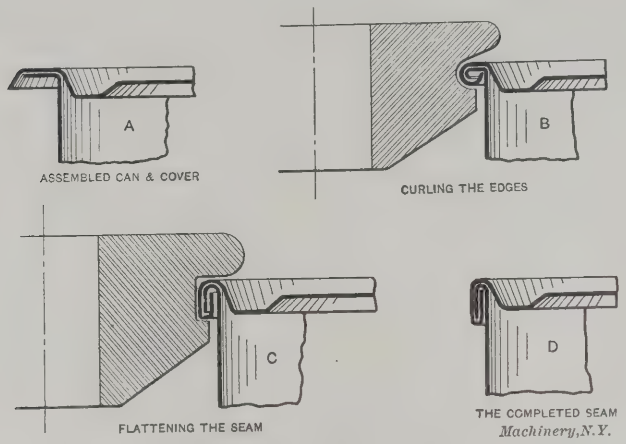

Fig. 4. The Sequence of Operations followed on the Double Seaming Machine

Fig. 3. The descent of the punch cuts out the blank between die *B* and punch ring *G*. The continued descent of the ram holds this blank firmly between *G* and pressure ring *C*, which is supported on pins *D*, which, in turn, are acted on by heavy rubber springs beneath the bed of the press. The spring plunger *H* also serves to hold the blank on the inside against

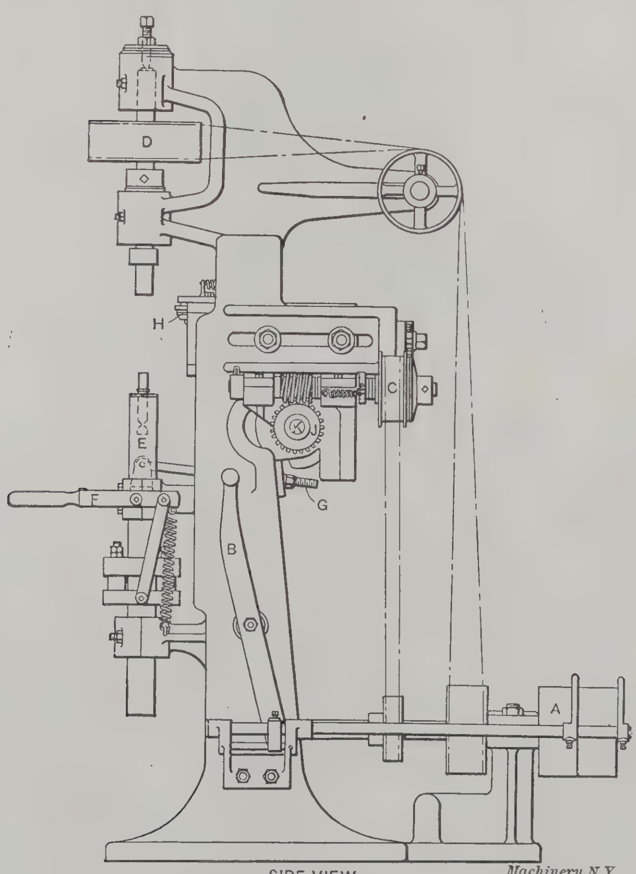

Fig. 5. Side Elevation of the Double Seaming Machine

forming die *F*. Pressure ring *K*, supported by springs *L*, has been holding the stock meanwhile. The blank thus cut out and held, is formed between dies *J* and *F* and ejected on the up stroke by the springs acting on members *C*, *H* and *K*.

As mentioned, the forming of the joint between the cover and the body is a cold process. It would be difficult to make this joint tight on a metal to metal fit, a leak being liable to occur near the seam of the body. To prevent this, the can covers are fed into an automatic machine, which deposits a very thin coating of an odorless and harmless compound in the groove of the cover, where the joint is made. This machine, which we are unable to show here, is simple and effective, and furnishes the means for rendering the can absolutely air-tight.

The Double Seaming Operation

The bodies and the covers are now ready for the seaming machine, in which is incorporated the basic feature of the process. In the old process, the can cover is made with a flange, fitting the body and soldered to it by an automatic process. In this case, however, the body and the can are rolled together into a double-lock seam by the series of operations indicated in Fig. 4. The can and cover are shown assembled at *A*. At *B* they are supposed to be held together and revolved rapidly in front of the first forming roller, which curls up the lips of the body and cover as shown. This roller then retreats and the second one comes up, flattening the seam firmly and neatly, as shown in progress at *C*, giving a result like that shown at *D*, where it is, however, shown somewhat loosely joined to more plainly indicate the construction. The seam is an exceedingly straight and neat one, and is rendered hermetically sealed by the lining process for the cap, previously described.

The machines for performing this seaming operation are shown in detail in Figs. 5 and 6, and in elevation in Figs. 7, 8

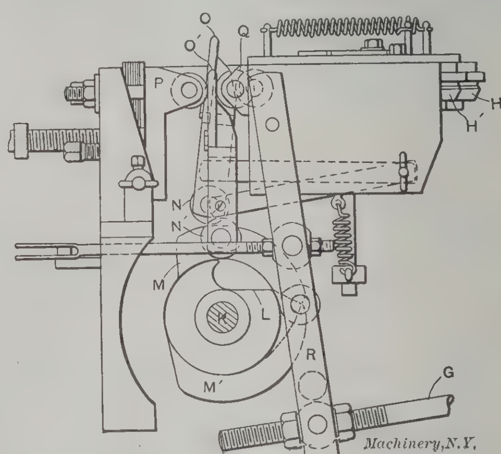

Fig. 6. The Cam Mechanism of the Seaming Machine

and 11. The can body is placed on a face-plate pivoted on spindle *E*, on which it loosely revolves. A similar face-plate is keyed to the upper spindle, driven by pulley *D* from driving pulley *A*. The cover and body are held together between these two face-plates, the pressure for this purpose being applied to spindle *E* either by hand or automatically, as will be described. As soon as this pressure is applied the can commences to revolve rapidly. The two rollers are in the position shown at *H* in Fig. 5, side by side. The mechanism for actuating them is shown more plainly in Fig. 6, which represents a view taken from the opposite side of the machine from that shown in the previous illustration.

The cam-shaft *K* (driven by worm-gearing *J* and pulley *C*, see Fig. 5) carries cams *L*, *M* and *M′*, which respectively operate levers *R*, *O* and *O′*. Lever *R*, by means of reach rod *G*, automatically raises spindle *E*, clamping the can and starting it to rotating. Levers *O* and *O′*, which are provided with wedge faces at their upper ends, as shown, enter one after the other between rolls mounted in back-stop *P* and slides *Q*. The latter furnish the support for rolls *H* and *H′*, which are thus brought successively into operation, forming the seam as shown in Fig. 4. The cam mechanism stops at the completion of the operation, and is started again by the operator when the work has been removed and new pieces placed in the machine.

In Fig. 7 is shown a machine of the same construction, but provided in addition with an automatic feed, the nature of which will be readily understood from the engraving. The cans are fed between guides on the work-table, as shown, from which they are advanced step by step by a pair of holders on each side, which advance, seize the cans, move them up into place between the spindles, open out and retreat for an-

other hold. An automatic ejector is also provided for removing the work from between the face-plates.

By the means just described, the cans are provided with a body and a bottom. They are now filled with the product for which they are to be used. It should be noticed that this

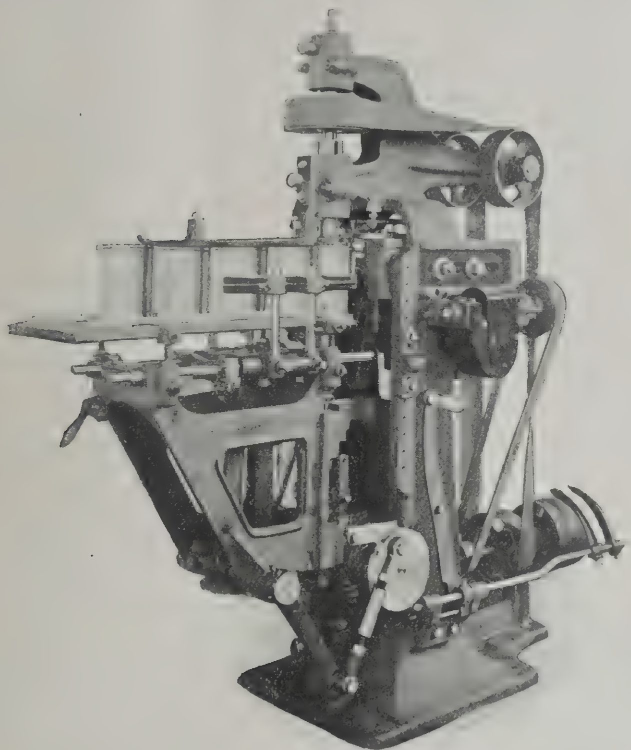

Fig. 7. Automatic Double Seamer for Cans for Food Products, from the One Pound to the One Gallon Size

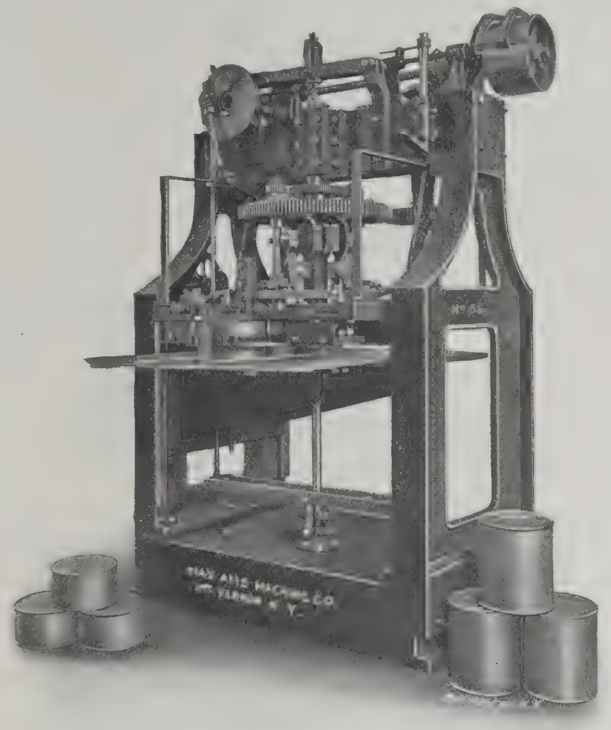

Fig. 8. Automatic Double Seamer for Large Cans for Meat, Fruit, or Paint, up to Five Gallon Size

filling is done through the full opening in the top of the can, instead of through a small opening in the cover, as is usual in soldered cans. This permits filling without special machinery, and without waste from slopping over outside of

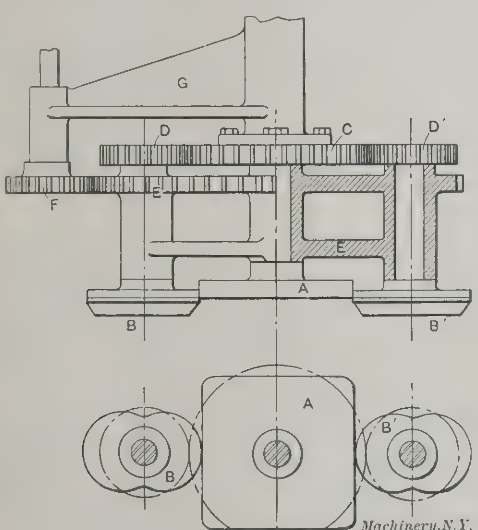

Fig. 9. Principle of the Machine shown in Fig. 8, when used for Square Cans

small openings. It also permits the easy canning of bulky materials, such as large fish, fruit, etc. After filling, the cans are again put through the same machine, and the cover is rolled and seamed into place by the same process, without the use of acids and solders, as previously described.

Seaming Machines for Square and Irregular Cans

A modification of this seaming machine is shown in Fig. 8. This operates on the principle illustrated in Fig. 9. In this machine, the can, instead of revolving, is held stationary, while the rolls are rotated and run around the edge. This is done sometimes for round cans where it is not desired to rotate the can, and it is the method always followed for square and irregular shapes of cans. The principle of the device as applied to a square can is shown in Fig. 9. *A* is the stationary can, and *B* and *B′* are the first and second rollers. It will be seen that these are of a contour to match the outline of the can *A*, when their centers are rolled about it in a circle. The face-plate *A*, which presses down on the can, is stationary. The frame *E* is revolved about it by the pinion *F*, meshing with gear teeth *E*. Journals are formed in *E* for the spindles, which carry rolls *B* and *B′*. The upper ends of these spindles carry gears *D* and *D′*, meshing with stationary gear *C*. It will thus be seen, that as frame *E* is revolved, rollers *B* and *B′* will also be revolved following the contour of the can and face-plate at *A*. The pitch lines of gears *D*, *C* and *D′* are shown in the lower diagrammatic view of Fig. 9.

Suitable means are provided in the machine shown in Fig. 8 for forcing first roll *B* and then roll *B′*, successively in against the work, and withdrawing them at the completion of the operation. A feed of somewhat similar construction to that of the machine shown in Fig. 7 is used. These machines work with surprising rapidity, tossing the cans off so

Fig. 10. An Assortment of Can Covers sealed by the Cold Process

fast that it would seem to be hard work to take care of them as they are delivered.

This last machine is not only adapted to round and square cans, but to irregular shapes of the greatest variety. A few of these are shown in Fig. 10. The American cans have been standardized to definite dimensions and capacities, and few

fancy shapes are found among them nowadays. The two covers shown at the left of Fig. 10 are of Italian origin, and doubtless exemplify the artistic instinct of the race, which will show itself in a can of preserved fish as readily as in

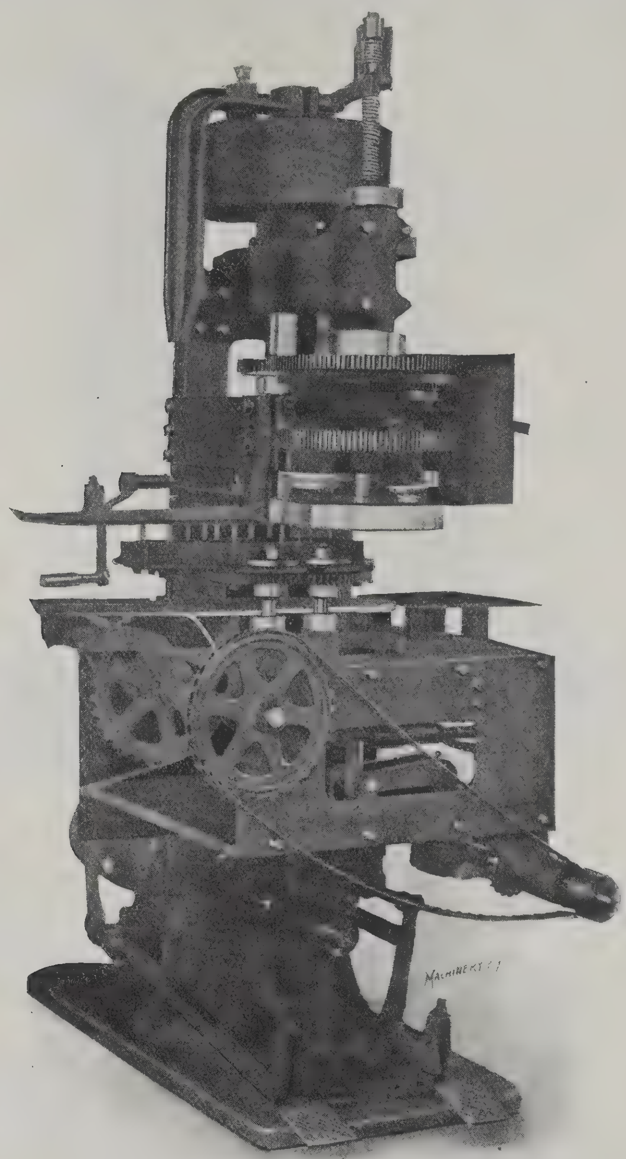

Fig. 11. Automatic Double Seamer for Condensed Milk Cans or Food Products

a marble statue or in an opera. This artistic instinct gives some difficulty to the man who lays out the rolls for forming the seam; but the job can be done to the queen's taste nevertheless, with care and experience on the part of the designer.

* * *

In the manufacture of the best grades of leather belting, a comparatively small section of a hide is used, this being a strip about 30 inches wide extending from the tail to a point just back of the shoulder, its length being about four feet. On account of the ignorance of most users of belting, and the difficulty of telling the grade of a belt except by use, certain leather belt makers are not over scrupulous as to the grades of leather entering their product, and we find not only is the section mentioned used, but flanks and other undesirable parts which are doubled with first grades in double belting. A belt made up in this manner may not in appearance be inferior to a belt made only from first-class parts, but in use it is bound to give inferior service. The use of the poorer grades with the best grades of leather belting is particularly bad. The inferior grades soon stretch, throwing almost the entire stress of belt pull on the superior grade. The result of this uneven tension is to quickly deteriorate the belt. Probably a belt made up in this manner is inferior to that made of the poorer grades throughout. Making the belt of inferior grades throughout has the merit of equalizing the stretch, keeping both parts in even tension.

A NIGHT-SCHOOL COURSE IN BLUE-PRINT READING

GEORGE A. HEPKE*

From time to time there have appeared in technical magazines and journals articles pertaining to courses as taught in night schools, in which the best way to present such courses in order to get the desired results, was discussed. I have followed these articles rather closely, but I do not remember having seen one in which the method of teaching blue-print reading is treated. No doubt, many of MACHINERY'S readers will be interested in the plan I followed in teaching the subject to a night-school class composed of pupils who were working in the different manufacturing establishments and who were handicapped by not being able to read blue-prints.

The idea was to cover about the same ground as a course in mechanical drawing, but in a much shorter period of time. The pupils desired to be able to read a blue-print correctly, but they did not want to spend the time necessary to become proficient in drawing. Nevertheless, they were desirous of understanding how projections, etc., are derived. At first a temporary schedule of instruction was arranged, but this had to be departed from during the course in order to meet the conditions. The course, as originally planned, was to include twelve lessons, one each week of 1½ hour duration. On the opening night there were ten pupils in the class-room, who ranged in age from 20 to 35 years. They were all followers of mechanical trades in local manufacturing establishments, working as molders, machinists, pattern-makers and core-makers. It was evident after questioning the pupils that it would be necessary to start with elementary work. They understood an object in the plan view, but as soon as it was turned and another view projected, they were at a total loss as to what the different lines then represented. In order to present this subject of projection as clearly as possible, wooden blocks were made as shown in the different illustrations, the construction of which will be explained in the descriptions of the lessons. These blocks, together with blackboard illustrated lectures, aided greatly in making things appear simple and clear.

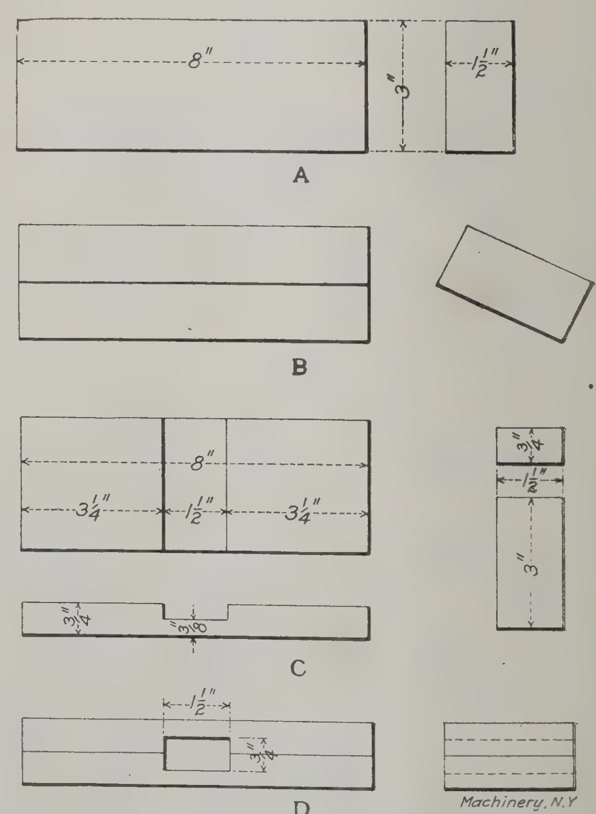

Fig. 1. Built-up Rectangular Prism used in teaching Projection

In the beginning, the difference between perspective and mechanical drawing, and why the former cannot be used extensively in mechanical lines, was explained. In begin-

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ning the instruction in projection, a drawing of an assembled rectangular prism (built up of three parts) showing all the full lines but no dotted lines whatever, was made as shown at *A*, Fig. 1. As no dotted lines were shown, the prism appeared as though it were made of one piece, but in reality

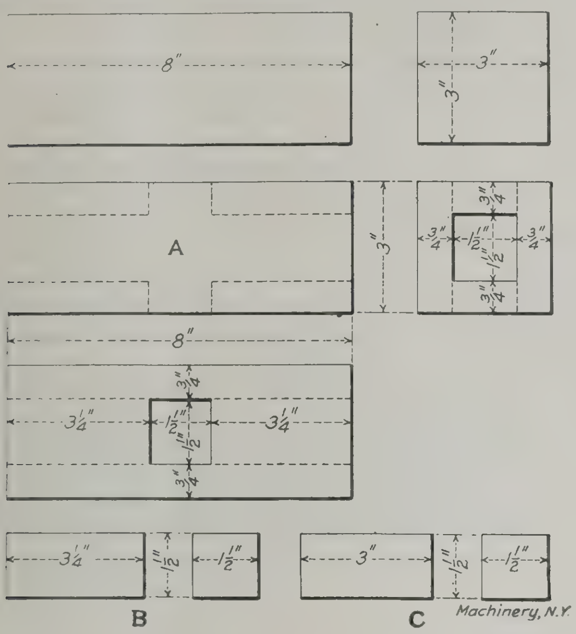

Fig. 2. Another Built-up Block with which Various Forms can be obtained for teaching Projection

it was composed of the three pieces. This prism was next projected as shown at *B*, after which it was taken apart and the pieces which formed it, projected as shown at *C*. This was done to illustrate how the channel through the center would be indicated on a drawing. Two of the three parts which form the prism were then placed together, as shown at *D*, which made it appear like a solid block with a hole cut through it. This hole gave dotted lines in the end view as shown. To illustrate the need of dotted lines, I used clear

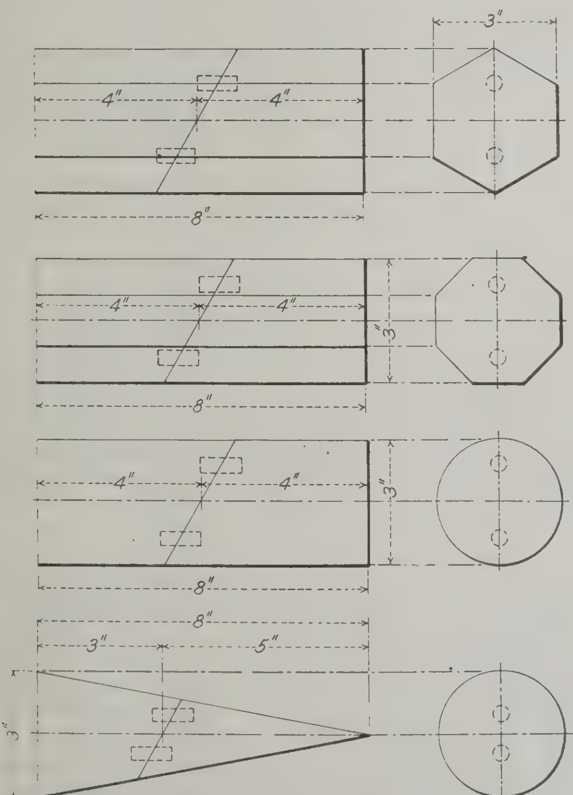

Fig. 3. Prisms, Cylinder and Cone, which were also used in teaching Projection

glass as an example, and the pupils were told that if the piece as assembled were made of glass, the lines representing the hole cut through the prism would appear full, but as the piece was made of a non-transparent substance, dotted lines were used to represent lines that did not appear to the eye.

The square prism shown in Fig. 2 was the next object used, and about the same instruction was given as with the rectangular block. This prism was composed of one piece *A*, two pieces *B*, and one piece *C*. When these pieces were put together we had a solid square prism and by taking them out, projections in which dotted lines appeared were obtained. The next objects drawn were the hexagonal and octagonal prisms, after which cylinders and cones followed in the order mentioned. With the different prisms made as shown, we were able to get quite a number of combinations and projections.

At first, only projections of the complete solid bodies were taken as shown in Fig. 3. The blocks which were held together by dowels, were then taken apart so that the projecting of angular surfaces could be practiced. As shown in Fig. 4, all the lines were designated by letters, so that the corresponding lines in different views could be easily located. These letters were found to be a great aid. The idea in giving the pupils the angular projections was to fit them so that when they encountered round bosses or pads of other shapes shown at an angle on a drawing, they would readily see how the projections in the plan or other views were derived.

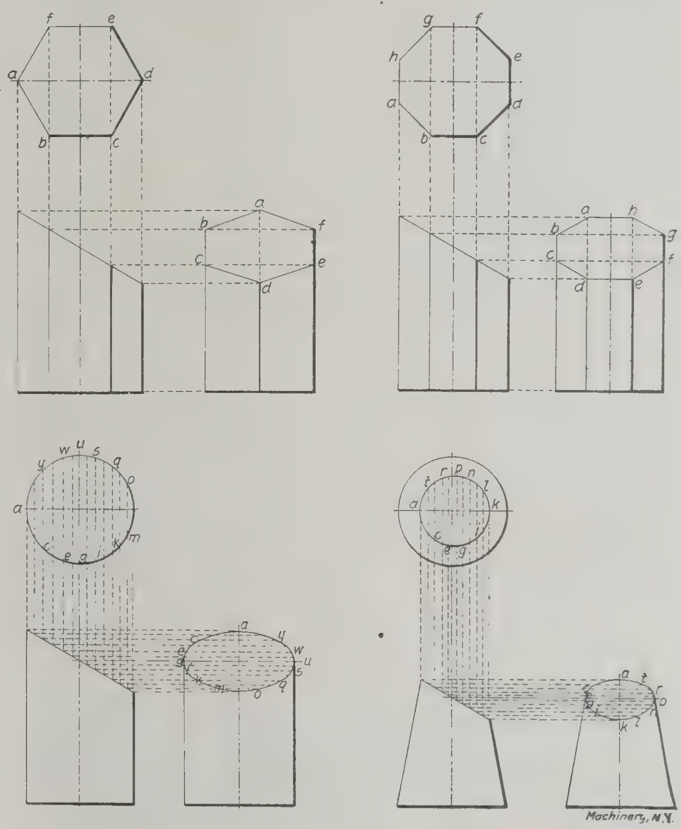

Fig. 4. The Blocks shown in Fig. 3 taken apart and used to teach the Projection of Angular Surfaces

Five lessons were devoted to the routine just mentioned and projections were covered quite thoroughly, but this work had to be supplemented by practice still to follow. It was during these five lessons that I discovered that the pupils had the most difficulty in learning in what direction the object was turned or set up to get a given view. The wooden blocks proved very effective in overcoming this difficulty, as they could be turned in whatever direction was necessary so as to correspond with the different views on the blackboard. During the five lessons mentioned the pupils were given the task of making drawings on the board of the different blocks, after a cut-out or something of that sort had been indicated upon the blocks with chalk. They did fairly well with this work, which enabled the judging of their progress, and also whether or not they understood projections.

The next step was to acquaint them with sections and sectioning. Different sections of simple objects, such as the blocks, for example, were drawn, and instructions given in following up a drawing in order to tell at just what point the section was taken when this was not indicated by letters. The type of sectioning for the different metals was also brought up, because in a great many assembly drawings

the kind of metal is not specified, the type of sectioning taking care of that.*

Taps and threads were next discussed, and the different ways of showing threads was explained. Thread pitch and lead were also brought up, and it was explained that where the number of threads and pitch are not given, it could be taken for granted that it was a United States standard thread or whatever standard the firm recognized. In brief, all of the kinks and short cuts that are in general use were explained, such as showing shafts, etc., broken, driving fits, and the method of designating bearings on shafts, with cross lines. The object in explaining all these points was to familiarize the pupils with such things, as I have discovered that the majority of mechanics have not the least idea what these short cuts and kinks represent and are often confused by them.

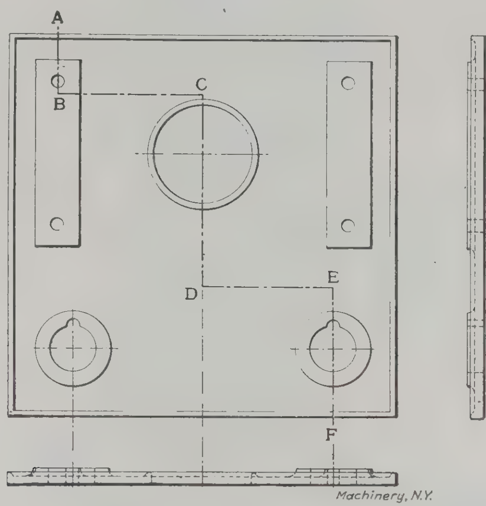

Fig. 5. Type of Drawing used for the Elementary Exercises in Blue-print Reading

The next subject treated was gearing. The different kinds of gears were described and the meaning of pitch diameter, outside diameter, pitch angle, turning angle, cutting angle, and the words addendum and dedendum, were thoroughly explained. We then took up the drilling and tapping of flanges, and all the terms of abbreviations generally used for this work, such as B. C. for bolt circle, D. C. for diameter circle, 2 Up for staggering center line, 1 Up for on center line were given. After that the method of indicating center lines and dimension lines was explained, and also that the arrows at the intersecting lines show that the piece is of the shape given on the drawing for the length between the arrows. Scaling of drawings was also treated, and the method of getting the approximate dimensions of a piece with an ordinary 2-foot rule when the dimensions are not given, and the drawing is made to scale, was explained.

Up to this point a blue-print had not been touched, for my object was to so acquaint the pupils with the various points mentioned that they would make rapid progress when the blue-print reading began. The first blue-print used was that of an engine cylinder sole-plate, as shown in Fig. 5. This simple drawing puzzled the pupils a little because of questions asked them, all the points of the preceding lessons serving as a basis for the questions. Other blue-prints of sole-plates of different types were thoroughly covered by taking sections at different points and showing these on the blackboard. As the students wanted to do a little work at home, I had them draw a section of the sole-plate through *A*, *B*, *C*, *D*, *E*, *F*. They did this work very well though they were somewhat confused at first.

The next lesson consisted of engine disk cranks, a governor gear-box, and other prints which were a little more difficult than those of the preceding lesson. The same tactics were followed with these prints, and the pupils were also given more home work, with the result that a decided improvement was soon noticed in their sketches. More and more difficult prints were used as the course continued, with the result that at the end of the twelve lessons, the students had a very good idea how to read a blue-print correctly, but the thing still needed was practice in order to develop this knowledge.

They were now greatly interested and demanded that the course be continued for twelve more lessons, which was granted. We resumed our studies where we had left off, always taking up something more difficult. Some of the lessons consisted of drawings of large pieces, such as engine beds and cylinders, fly-wheels and other large castings. Another line of blue-prints used were those of a 300-ton hydrostatic wheel-press. All the different parts of this press were located in the assembly drawing from the details, and the work was conducted the same as if the class were machining and erecting the complete machine. The pupils were also required to draw sections of the various parts, such as the one illustrated in Fig. 6. After finishing with the press prints, assemblies were dealt with, some of which were rather complicated drawings, until the end of the term.

I do not claim that any of the pupils were experts at the end of the course, but I think that they had a good foundation for development. Had the pupils been familiar with projections we could have covered the same course of study in a much shorter period, and also would have gained considerably more ground. Nevertheless, I am perfectly satisfied with the results when the conditions under which we started are taken into consideration. The course as outlined in the foregoing would probably not work so well in another case, as everything depends upon the men and the conditions, but it will doubtless have suggestive value.

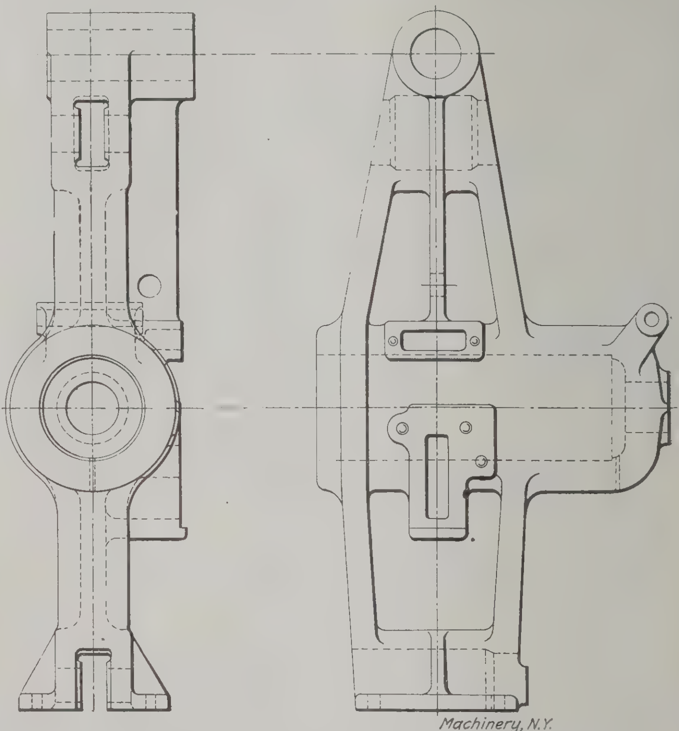

Fig. 6. Detail Drawing used in connection with more Advanced Work

* * *

Referring to the item published in the July number of MACHINERY on the use of "victimized power" in operating penny-in-the-slot machines, in which it was made apparent that the action of the operator was a necessary element in the success of such machines, attention is called to an article in the July 3 number of the *Saturday Evening Post* by Mr. Frederick Thompson, in which he points out that this is a prime factor in the success of all amusement enterprises. Those enterprises are most popular in which the people amuse themselves, the apparatus, game or device being such that the chief factors in the sport are the people taking part. The tickler, witching waves, shoot the chutes, and other devices that have proven enormously popular afford as much or more amusement to the onlookers as to those who participate in the games.

* The practice of indicating the character of materials by cross-sectioning should be abolished. There are no generally accepted forms of cross-sectioning for the common materials even, and as for the less common materials, almost every draftsman feels free to use the form that appeals most to his fancy. In all cases the material should be plainly specified by name.—EDITOR.

ELEMENTS OF ASSEMBLING OPERATIONS*

ALFRED SPANGENBERG†

The machine shop operations usually discussed by various writers have been almost entirely associated with machine work. Aside from this, and a factor of equal importance, is the subject of assembling. In its broadest sense, assembling may be defined as the operation of combining and adjusting the separate parts of each unit in such a manner that these units, when in combination, will properly perform a predetermined function. The operation of fitting is often included in the work of assembling; under ideal conditions, however, a distinct line of demarcation can be drawn, so that the term "fitting" will only apply to the operation of machining.

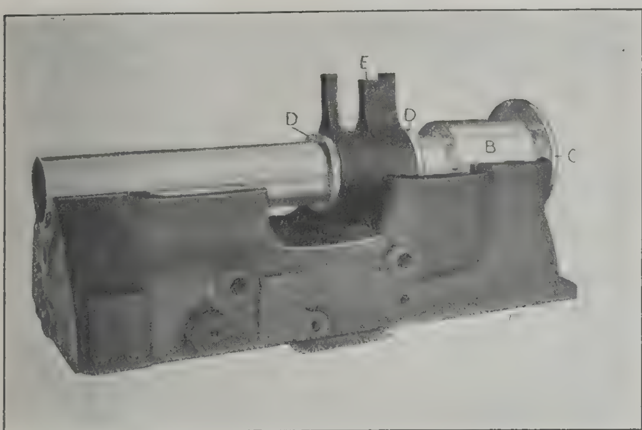

Fig. 1. Method of Gaging Clearances for Spindle Gears in a Lathe Headstock

The purpose of this article is to show the possibilities that lie in developing methods of assembling that will ensure accuracy, economy and standardization, but before giving any concrete examples, it will be well to consider briefly the elements that directly affect the cost of assembling operations. The determination of proper methods and processes of assembling are peculiarly difficult, since the elements of human judgment and skill enter so largely into this work. It is a far more puzzling proposition than that of analyzing and determining the best method for machining any particular part. For this reason, the study of assembling work requires particular care and especially keen analysis.

The Three Factors Leading to Economical Assembling

Accurate drawings, accurate machine work and the use of jigs and gages, are at the foundation of economical assembling. Without these factors, the term "manufacturing," used in its limited sense, really does not apply to the scheme of production. Much has been written on methods of dimensioning drawings and the use of limits as tending to accurate and at the same time cheap production, so that little need be said here on the subject. The system of giving all unimportant dimensions in inches and common fractions thereof, and expressing precise dimensions in thousandths of an inch with the permissible limit of variation, is worthy of wider application. This, coupled with a thorough system of inspection, will insure that the parts function properly when assembled, besides preventing a choice of methods in machining that may entail a vast amount of work when less elaborate methods will produce a job that is good enough for the purpose. While the use of limits on drawings has been unsuccessful in many cases, the principal cause of its failure probably has been due to an injudicious selection of the maxima and minima for different classes of work.

In order to insure the accuracy of the machine work, it is absolutely necessary to provide for a thorough system of inspection in the machine departments. Some manufacturers only provide for inspection of the finished product and refuse to admit the advisability of adopting the broader plan. To state an important point which the author shall want to emphasize, we must always keep in mind not only the possibility of wasted money through excessive time in having to "fit" the parts in the assembling department due to poor machining, but *especially* the waste of valuable time in having to wait for parts to be replaced that have been spoiled in machining, the error not being discovered until ready for use. In brief, it is short-sighted to imagine for one moment that anything like economical results will be obtained in assembling unless this provision is made.

The great value of, and necessity for, jigs and fixtures on duplicate work and their bearing on the cost of assembling is too well recognized to need any further comment here.

Method of Investigation and Analysis

First of all, a careful analysis of the assembly drawings should be made in order to thoroughly understand the purpose of every part of a machine. This is an important consideration and will lead to the adoption of methods that will prevent undue accuracy and unnecessary expense consequent thereto. It is a mistake to accurately align and fit parts that may be said to "fit a hole in the air." The time needed for this can be more profitably spent on those parts that require accuracy and refinement. The purpose of every part should be studied; the operation necessary to produce it can then be regulated accordingly.

A matter that should receive careful attention is the question of rigidity in fits. Those of us who have "been through the mill" are painfully aware of the fact that most workmen fail to distinguish the difference in rigidity required in the fit of a lathe spindle from that necessary in the case of a shaft for operating a clutch lever. An illustration in support of this statement is afforded in the case of an automatic machine that recently came under the writer's observation. The machine in question was built by a manufacturer having a reputation for turning out very accurate work; in fact, the fits were so tight that at times certain members of the feed-stop mechanism would fail to function properly with the result that a part of the machine would be wrecked. After these members were fitted free enough, no further trouble was experienced.

Varying conditions make the determination of proper fits and adjustments in assembling work a question of experience and judgment. As a general proposition, sliding or revolving machine elements that do not affect the accuracy of the machine's product should be fitted perfectly free, so that there will be no indication of the parts working stiff. This applies especially to spring- or hand-operated mechanisms. Sometimes,

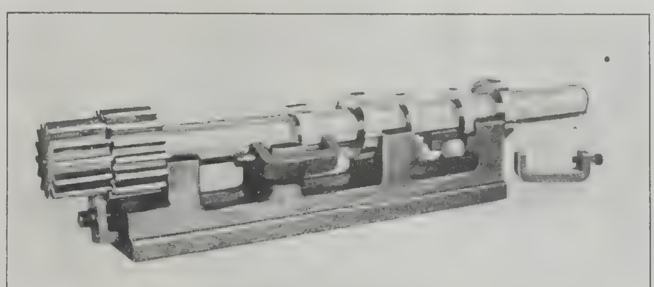

Fig. 2. Jig for Drilling Pin-holes in Collars on their Shaft, to insure Interchangeability

however, the fact that these elements are apparently fitted or adjusted too tight can be attributed to their being out of proper alignment.

The next logical step in the study of the drawings will be to map out systematic and well-defined methods and processes of assembling so that the parts may be quickly and cheaply assembled, all will be in their proper relation to each other, and that the alignment of the various parts will be perfect within the required limits. Various ways of accomplishing the object sought will present themselves successively; unless special considerations prevent it, the process that will accomplish the object sought in the most direct manner is the one to be chosen. This consideration shows the importance of a thorough knowledge of modern methods, the facilities at command, the organization itself, and special tools and appliances.

General Requirements for Efficient Work

The drawings must always be followed. No deviations should be permitted. If any mistake is discovered or change found necessary in the interest of economical assembling, then

* For additional information on this subject, see MACHINERY for February, 1909, "Application of Lifting Devices to Assembling Work," and April, 1909, "Labor-Saving Devices for Scraping Operations."

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these corrections should be approved by responsible parties and made on the drawings. The importance of this is at once apparent. Standardization without observing this rule is impossible, and neglect of it will result in lax, inaccurate, and totally misleading methods of production. Again, in case of repairs, the new parts can be finished to the drawings with the assurance that they will fit properly. The drawings should always indicate the method of oiling a mechanism, as this matter, if left to the judgment of the assembler, may result in an inefficient system of lubrication.

If any errors are found to exist as a result of mistake in patterns or fault in casting, then these mistakes should be taken care of at once, so as to prevent a repetition on succeeding pieces. In the case of clearances this will prevent unnecessary "carving" to be done either by chipping or machining. In many instances, however, when the clearance allowed on rough castings is small and the design will not permit a change, it is unreasonable to expect avoidance of "carving."

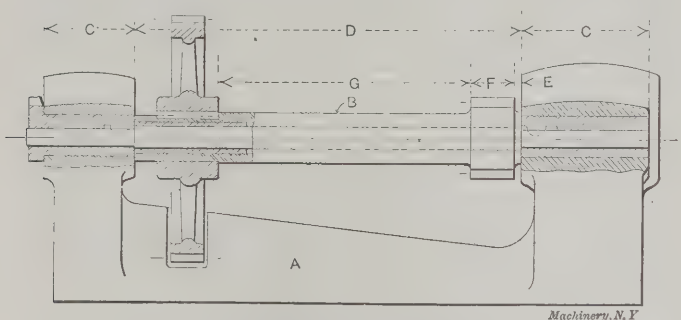


Fig. 3. Illustrating a Case where the Micrometer can be used advantageously for Length Measurements

Such cases should be anticipated before any assembling operations are commenced, and the necessary clearance made by chipping or machining so as to prevent having to take the work apart.

This principle is clearly illustrated in Fig. 1, which shows a lathe head-stock. For special reasons the clearance allowed in the head-stock casting for certain gears that run on its main spindle is very small. The gage for testing this clearance consists of a hollow arbor *B* having a locating flange *C*. Mounted on this arbor and free to turn between the collars *D* is the gage casting *E*, which has a contour 1/16 of an inch larger than that of the gears above referred to. By turning the gage it is very quickly determined whether there are any irregularities on the head-stock casting to be chipped off. The

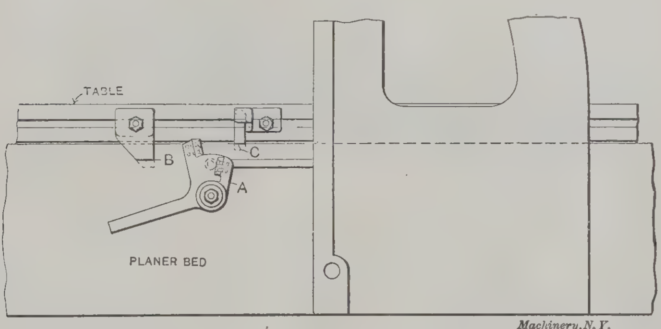


Fig. 4. Example of Work where some Fitting is left for the Assembler

advantages of using this gage are that the irregularities can be more easily seen than by using the gears and spindle; any necessary chipping is done before the assembling operations are commenced; and the gage, being light, is quickly and easily handled.

Much profitable study can be given the question of substituting the machining process for operations that are usually performed by hand, such as chipping, filing, etc. Oil grooves should be machine cut on all pieces that can conveniently be handled on a machine; tap holes can be tapped cheaper on a machine than by hand, except in the case of very small holes in large pieces; set-screw holes in shafts should be drilled on a drill press. The halftone, Fig. 2, illustrates the method of locating and drilling collars on a shaft in interchangeable work.

One example will suffice to show the possibilities of saving time in this direction. For many years it had been the practice of a certain machine tool builder to chamfer the threads on all split-feed screw nuts by chipping and filing. It will be understood that this is necessary in the case of split nuts so as to permit their opening and closing on the feed screw, the chamfer being at the joint. On a certain size nut it formerly took twenty minutes per pair by the hand method. The same size is now milled, using two cutters simultaneously, in one minute per pair, which includes clamping and removing the work.

It is, of course, unreasonable to expect to entirely do away with these hand operations, but in many instances to-day much of the chipping, filing and scraping could be avoided if proper attention was given to the matter. Probably the most notable example of the tendency in this direction is afforded in the manufacture of automobiles, where the hand operations consist merely in combining and adjusting the various elements.

Standardization

Standardization, as already pointed out and emphasized, is one of the "secrets" of economical assembling. It is a matter of common knowledge that interchangeable manufacturing is really economical manufacturing, and yet in many instances its fullest possibilities are not realized. There are many shops to-day that still cling to the old custom of "making every piece like itself." The practices of leaving stock for adjustment on the hubs of bevel gears, facing off the ends of bearings to no particular dimension, planing taper packings to fit slides that are not planed to gage and adjusting parts to fit others that are not standard, must be eliminated if economical results are expected. Some very simple form of gage, such as an inside or outside micrometer, will enable work of this character to be machined standard and made practically interchangeable at a fraction of the cost in assembling.

An example is given in Fig. 3 to illustrate this point; *A* represents an engine lathe head-stock having a back-gear quill *B* running between the eccentric-shaft bearings as shown. The length *C* of the bearings and the eccentric bushings can be made to an outside micrometer, while an inside micrometer is used to measure the length *D* between the bearings, the proper allowance being made on the quill for a running fit. An ordinary scale is used to take the measurements *E*, *F* and *G*, and, if care is exercised, the gear and pinion on the quill will line up with those on the main spindle, if the same precautions are taken in the case of the spindle shoulders and gears.

The experienced man will smile at the idea of these quills having to be adjusted by the assembler, but the author recently visited a shop building small engine lathes where this practice was still in vogue.

Errors in measurements of length are far more likely to occur and cause trouble in assembling than errors in diameter. This is probably due to the fact that in the latter case instruments of precision, such as the micrometer or limit gage, are in more common use. Standard length gages are indispensable on interchangeable work, although in instances similar to that referred to in Fig. 3 scale measurements are accurate enough. The fact is that few workmen can, or really do, work nearer than 1/32 inch with a scale.

However, there are cases met with in assembling where it is not practicable to machine all the parts standard, owing to the fact that a number of conflicting elements enter into the problem, and make it advisable to leave stock for adjustment on certain pieces. A concrete example is afforded in the case of a planer reversing mechanism, which is illustrated in Fig. 4. It is obvious that the rocker *A* must swing through a certain definite arc, the amplitude being limited by the movement of the belt shifter cam (not shown) and controlled by the lengths of the dogs *B* and *C*. It is at once apparent that there are a number of measurements which must be considered; a discrepancy in any one of them would make a difference in the working of the mechanism, and the easiest and quickest way to fit the dogs is to swing the rocker in one extreme position and scribe a line on the corresponding dog representing the cam face on the rocker; then repeating the operation in the other extreme position of the rocker. The dogs are then taken off and sawed close to the line, after which the surfaces are smoothed with a file and the steel members removed for the purpose of hardening.

Duplication

The duplication of parts in quantities is another step in economical manufacturing. For special reasons it may not be advisable to build the complete machine for stock, but in nearly every instance the standard parts can be assembled in lots and kept in stock ready to be placed on the bed of the machine when ordered. The advantages are many. First, a large reduction in initial cost results because of this production in quantities. This is due to the fact that the same operations can be performed on a number of pieces in succession. Again, the possibility of always having these parts on hand when wanted means quicker deliveries.

Methods and Processes of Assembling

The methods and processes of assembling will, of course, vary with the character of the work and the design of the machine, so that it is impossible to outline any comprehensive system with the thought that it could successfully be applied

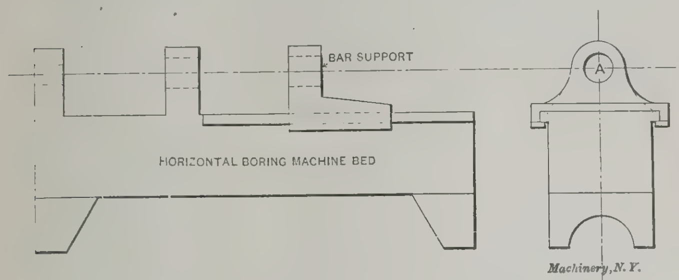


Fig. 5. A Case where some Machine Work is done after the Work is partly assembled

to all conditions alike. Indeed, a blind adherence to certain rules is liable to be a serious detriment. It is possible, however, to lay down a few fundamental principles which can safely be followed and which are adaptable to many differing conditions.

As was previously stated, the design and construction of a machine are intimately correlated, as becomes apparent when special methods needed for its construction have not been taken into account. For this reason, the designer should continually be impressed with the importance of bringing out the best possibilities of manufacture, both as to ease and cheapness of assembling, as well as machining. The tendency of modern machine design is toward the unit system of construction in which the various units comprising the driving members, feed members, etc., are self-contained, being placed in gear-boxes and bolted to the bed of the machine. This feature enables the various units to be assembled independently and simultaneously, and is an important consideration, since the shortest possible time in which any particular machine can be assembled depends upon the number of operations that can be carried on at the same time. The most notable examples of the unit system of design are afforded in modern drilling and milling machines.

On the other hand, when the design is such that the parts are more or less interdependent, it is possible to separate or classify into groups the various members so that the unit system of assembling can be followed to a certain extent. This is especially true of interchangeable manufacturing where the necessity of adjustment is eliminated.

This important feature should be emphasized that, in assembling work, it is highly advisable to provide for the same rigid sub-division of labor that exists in the modern machine department. Thus, the operations involved in assembling the units should be separated from the erecting process on the beds. In large shops these processes are carried on in different departments.

The operations involved in assembling, such as chipping, filing, scraping and fitting, are usually performed either at the vise and bench or on the floor, depending on the size or weight of the work; hence the name vise, bench and floor work.

Bench work is of a lighter nature than floor work, though it may, and often does, include the entire assembling process when the detail is small, and in case of large work many of the smaller parts are assembled at the bench and are then taken to the floor and adjusted to the other parts.

Floor work includes the erecting and assembling of heavy machines, and the machining of parts too heavy or too large to be operated on in the stationary machine tools.

In general, the sequence of operations is somewhat as follows: Work coming into the assembling department from the various sources should have all the machining operations completed, the only exceptions being in cases where it is absolutely necessary to leave stock for adjustment and where, owing to the fact that some parts are interdependent, it is not possible to carry on all the operations of machining at one time. A concrete example illustrating the latter case is shown in Fig. 5. It is obvious that it would not be practicable to bore the shaft hole *A* until the scraping operation is completed on the bed and carriage. In this particular case the support is bored in place on the bed.

The preliminary assembling operations of such parts as are interdependent consist of the chipping, scraping and aligning operations. Should chipping be necessary on parts that require scraping, then the chipping must be performed first in order to avoid having to take the work apart and to prevent the possibility of springing the pieces. Next in order are the scraping operations on such members as slides, carriages, ways on beds, spindle bearings, etc. This is to facilitate the lining up operations. On small work, the use of special surface plates enables the pieces to be scraped and made practically interchangeable without having to try the pieces together, while on large work the element of spring in large surface plates, besides other considerations, precludes their use. Special lifting and pulling devices such as those described in the writer's articles in the February and April issues of MACHINERY will greatly facilitate the work of scraping.

The determination of methods for quickly and easily lining up the various brackets, shafts, etc., is a matter that should receive careful thought. Whether or not jigs and fixtures are used will determine to a large extent the processes employed, although the final alignment of the brackets and bearings before the dowel pin holes are reamed, will be much the same in either case, the use of jigs saving the laying out of the screw holes. The halftone, Fig. 6, illustrates this principle and shows the method of aligning the brackets and feed-box on the head end of a turret lathe bed. Separate jigs are

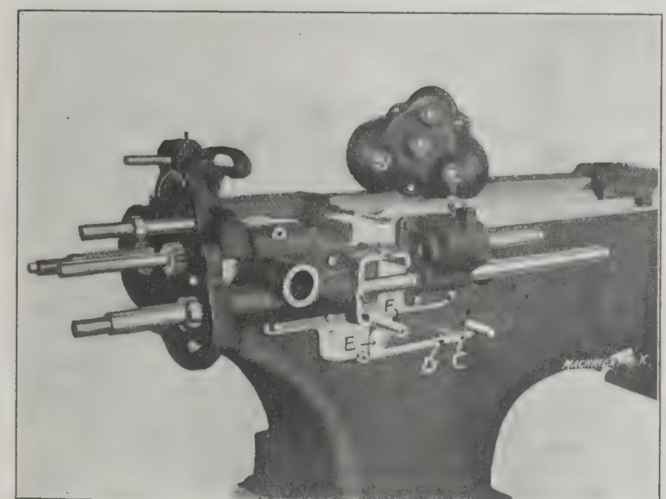


Fig. 6. Method of Aligning Bracket and Feed Box on the Head End of a Turret Lathe

used for each member in drilling the clearance and tap holes and in boring the shaft bearing holes. To align the bracket members on the bed for the purpose of drilling and reaming the dowel pin holes, special arbors are used to bring the shaft bearings in the brackets and gear-box in line with corresponding bearings in the bed. With the clamping screws only tightened sufficiently to hold the various members in place, the brackets are shifted slightly to permit the arbors to be turned freely by hand, which indicates that all the bearings are in proper alignment. The clamping screws are then tightened down, and the pinning operations completed. It should be explained that the gear-box cover is in place on its base during these operations; in Fig. 6 it is shown on top of the bed for the purpose of showing the arbors more clearly.

If jigs were not used, as explained above, the brackets and gear-box would have to be lined up and held by clamps for

the purpose of marking off the screw holes in the bed. Incidentally, the method of setting the stud C with reference to its slot for the connection D is shown. The sheet-iron gage E supports and locates the connection from the stud F.

In cases similar to that in Fig. 6 where it would be necessary to remove the shafts and gears in order to line up the brackets, it is advisable to perform this operation first. Otherwise, the units can be assembled complete, and then lined up on the bed.

The operation of assembling the individual units merely involves the chipping of oil grooves, hand reaming, fitting of keys, etc., and combining the various elements. Whether the units are sent to the storeroom or directly to the erectors, all operations of fitting and adjusting should be completed as far as possible. This will prevent the erectors from losing time by having to run to the vise and bench to fit the parts. Thus, in the manufacture of lathes, the head-stocks, tail-stocks, rests, aprons, etc., are assembled as complete units and are then sent to the erector to be fitted onto the lathe bed.

All work on the beds and such as cannot be performed when the units are fitted, is, of course, done by erectors. This includes the scraping of the larger pieces, the lining up operations as already explained and the final adjustments and testing of the complete machine.

The principal point to be observed on erecting work is to plan the method of combining and adjusting the various units on the bed of the machine so as to avoid having to take the work apart, due to neglect of some vital point. The practice of taking the work apart unnecessarily shows lack of forethought in planning the methods and processes of assembling and emphasizes the principle already outlined of mapping out the sequence of operations before hand.

A very careful consideration of all these problems and a serious attempt to solve them scientifically will bring surprising results. It hardly seems necessary to argue in favor of the adoption of the methods and processes advocated, since the experienced man will at once recognize them as being the most natural to follow. Yet the lack of effort to accomplish these results in most well-run shops (to say nothing of the poorly managed) is as singular as it is prevalent. In place of haphazard, inefficient methods must be substituted those that will lead to the adoption of standards proven by experiments and experience to be efficient, and these must be adhered to without deviation.

* * *

A German professor in a lecture on the chemical relations of aerial navigation pronounces helium to be the ideal gas for lighter-than-air airships. The professor points out that the gas is uninflammable and that it can stand a cold of —268.5 degrees C. without liquefaction. The first quality would, of course, be valuable, but as regards the second quality, its value is doubtful, as aerial navigation is not likely to put such a test on the gas used, and it would be interesting to know where the professor expects that the airships would be subjected to such a temperature, and also how he would expect the navigators to survive. Besides, the professor ought to have pointed out how to get the helium. The small quantity of one hundred gallons possessed by the Leyden University is not intended for public consumption. The professor, therefore, realizing the impracticability of helium, cheerfully advises the making of experiments with superheated steam!

* * *

The first steel plant south of Mexico is being built at Corral, Chile, and is expected to be ready for operation early in 1910. The daily capacity will be 200 tons. The machinery for this steel plant is principally of French manufacture. A fine quality of iron ore is found in large quantities within five miles of the plant, and for fuel will be used charcoal produced from the extensive forests in the vicinity; it is proposed to produce iron and steel of the highest quality. It is expected that the opening of the steel plant will encourage the development of many other industries that are dependent upon the iron and steel industries for raw materials. This will open a market for industrial machinery, and American manufacturers should keep in close touch with Chilian development for the next few years. Machinery enters the country free of duty.

THE MANUFACTURE OF GAGES*

T-Square

The introduction of our present gage system was made necessary by the development of our modern methods in the manufacture of interchangeable parts; a complete system of gages is absolutely essential to the accurate and economical production of interchangeable parts in large quantities. Some manufacturers have been slow to recognize the necessity of absolute interchangeability in their products. This has been particularly true of some machine tool makers; who

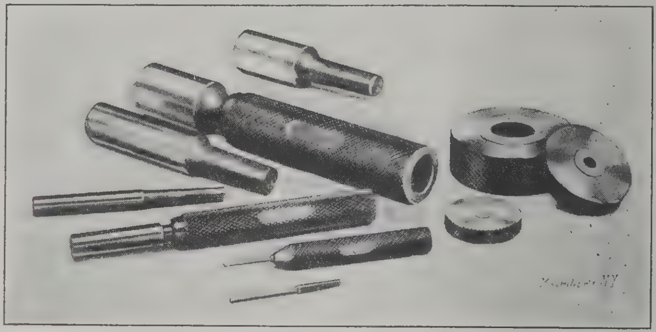


Fig. 1. Plug and Ring Gages of Approved Construction

has not seen half a dozen lathes of one make and pattern in the same shop where not even chucks were interchangeable?

Probably no class of manufacturers has more fully realized the necessity of absolute interchangeability than the makers of small firearms, and to gun makers is due much of the credit for the development of gaging systems and the training of highly efficient gage-makers. The standard methods adopted by them can, with slight modifications, be adjusted to fill the requirements of any manufacture; but the slow adoption of gaging systems is largely due to the manufacturer's prejudice which is often strengthened by ignorant or incompetent foremen who decry anything that savors of improvement, impelled by motives of fear that any innovation might carry beyond the narrow groove of their capabilities.

Principles of Development of a Gaging System

The manufacturer who contemplates the establishment of a gaging system must use the greatest care in the selection of his designer, for the question of economy hinges on the experience, foresight and ingenuity of the latter. The designer should be a man familiar with shop methods, and must be on good terms with the men with whom he must

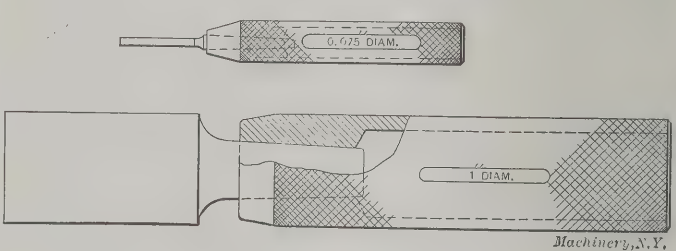


Fig. 2. Plug Gages and Handles

cooperate. In this way he will be able to gather considerable information which will be of great assistance to him in the production of efficient results.

The designer must satisfy himself that each piece being machined is handled to the best advantage, and that each cut or operation is in proper sequence. Having done this he can then lay out his gages in such a manner that each operation will have its own equipment, independent of other operations, thus insuring uninterrupted progress of the work.

In machining parts intended to be interchangeable it is necessary first to establish certain working points which are maintained throughout the entire series of operations. In some cases the working point must be shifted during the progress of the work, through the creation of a more important point after the taking of some cut, or the necessity of cutting away the original point. Very often two holes (not always neces-

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: A Few Suggestions in Tool-Making, May, 1904; Lapping Flat Work and Gage Jaws, November, 1907; Making Thread Gages, February, 1908.

sary to the completion of the work), drilled and reamed in the piece, are used for locating it on pins inserted in the various jigs and fixtures, thus bringing each piece in like relation to the cutting tool after the proper setting has been established. And, again, it is sometimes found expedient to use one hole, and one surface, or one end and one side as holding points, and the designer must ever bear in mind that he must gage from the same point from which the piece is located or held, whenever it is possible to do so, although, of course, there are exceptions to this rule.

Should the parts on completion of the machining operations be required to pass through a system of inspection, before being assembled as a whole, which is the custom in some lines of manufacture, the gage designer is confronted by an entirely different set of conditions. He has then to do with the finished piece, and does not consider the intermediate stages. He should study the mechanism of the assembled machine, and must understand the function of each piece, and the relation it bears to all other parts; then will he first be

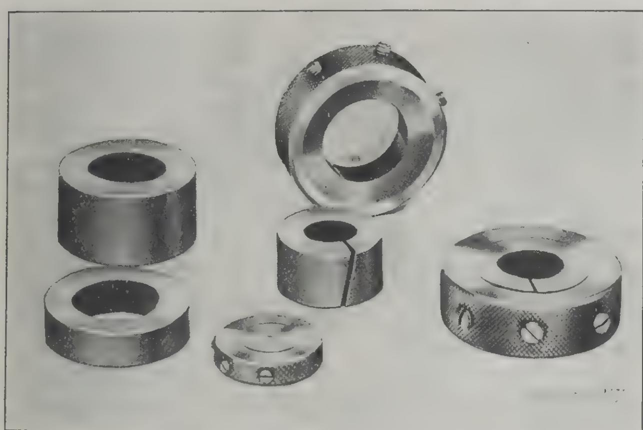


Fig. 3. Lap and Lap-holders used for Making Plug Gages

able to produce gages which will correctly test the vital points, with accurately established limits of tolerance.

The next essential to the economical inspection of parts is to limit the number of gages to as few as possible; when considering that parts are often made in lots of from 5,000 to 50,000, and each piece is to be inspected, the importance of this will be readily understood. It is *common* practice to combine gages of the simpler forms, such as a series of snap gages, or snap and profile gages, on the same plate; or a number of ring gages inserted in a plate also bearing snap or even profile gages. It is not, however, *good* practice to combine profile gages with any other type, as their longevity is much greater than that of any other form.

It is on the manufacture of the simple, but much used plug and ring gages we shall treat in this article, not with the old time machine shop conception of a gage, as something unquestioned (but often questionable) as to accuracy,

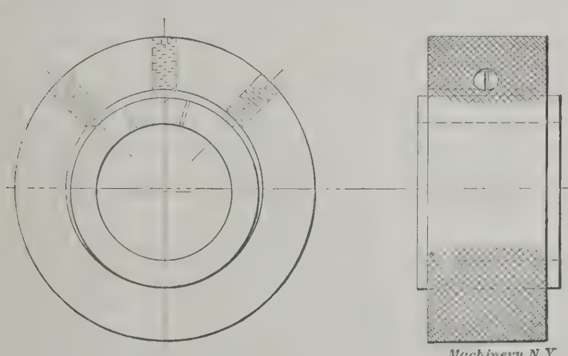


Fig. 4. Design of Lap and Lap-holders for Making Plug Gages

to be locked up in the boss' desk and brought forth only on state occasions, and given out with many solicitations for its care, and its safe return; but as something made in quantities, to be used, worn out and replaced.

The Making of Plug Gages

Our earliest, and in some cases, our latest, recollection of a plug gage is an unwieldy affair, either knurled or fluted on the handle end, and made of solid tool steel throughout, expensive to make and clumsy to handle, requiring much valuable stock in the making, and extreme care in the tempering (although the latter is always commendable as the danger of water cracks is always imminent). However, we now have a much improved design not only convenient to handle and symmetrical in form but comparatively inexpensive to make, and with the risk of loss in hardening reduced

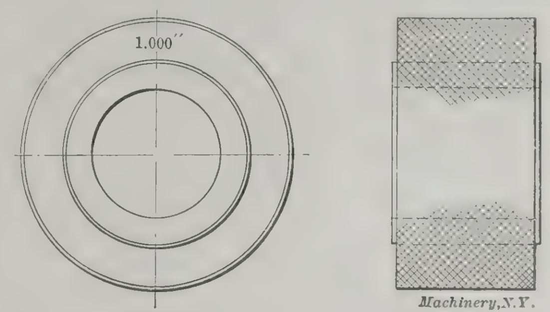


Fig. 5. Approved Construction of Ring Gages with Holders

20 to 50 per cent. This last depends first on the compact design, separate from the handle, and secondly, on the small amount of time expended up to the point of hardening, thus reducing the pecuniary loss when breakage does occur.

Although the designs of these gages, as produced by various makers, differ slightly, the fundamental principle is the same, *i. e.*, to insert the plug proper into a handle from which it can be easily removed, and replaced by another if desirable. The most popular, cheapest and best form, adaptable to plugs from 0.075 inch diameter upwards, is that with the taper shank. These plug blanks are made on a screw machine from drill rod or bar stock, by simply turning the taper shank and cutting off to any desired length, usually ranging from ¾ inch to 2 inches on the straight part. They are then centered for turning, grinding and finishing the straight portion, no further work being necessary on the shank. A number of such gages are shown in Fig. 1.

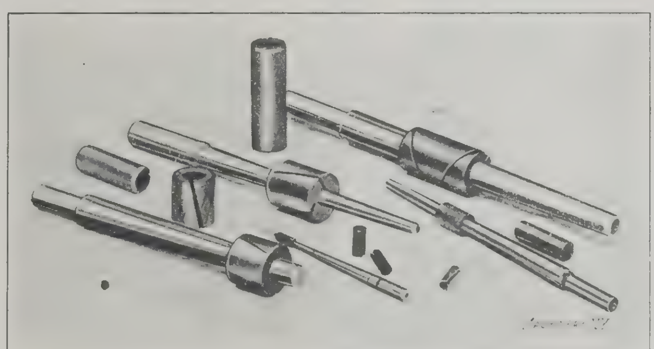


Fig. 6. Lap and Lap Arbors used in making Ring Gages

Knurled handles as shown in Fig. 2 are made in standard sizes, each accommodating a certain range of plugs. These handles, being of machine steel, can be turned out very cheaply on a hand or automatic screw machine, when, after stamping size or other desirable marking on spot flatted for that purpose, they can be blued if desired. They are then ready to receive the plug, which is simply driven lightly into the taper end, and when necessary, can be easily driven out from the rear.

Plugs ranging in diameter from 0.075 inch down, should be made from straight hardened wire, which need not be ground, but simply lapped to size, and sweated into the handle, which can be made in the same manner as for the taper shank plugs, but with the front end left solid, and afterwards drilled to suit any desired size. This method of inserting in the handle obviates the necessity of centering, turning or grinding, and the solder will be found sufficiently strong to withstand the torsional strain on a plug of small diameter. As the breakage of these small plugs is quite frequent, this will be found a very cheap and satisfactory means of production. The wire can be bought in a great variety of sizes, and for any given size of plug, wire should be used 0.001 inch larger in diameter, which will be sufficient allowance for the lap to clean up any surface irregularities.

The taper shank plugs ranging in diameter from 0.075 inch upwards, are handled differently. When the blanks are made from bar steel, they should be at least 0.080 inch larger in diameter than the required finished size, as this will insure turning off the decarbonized surface of the bar, and reaching the more uniform structure beneath. In the case of those made from drill rod but half of this amount is necessary. After centering with a small center reamer (large centers should be avoided as they sometimes induce water cracks), the plugs are turned smoothly to within 0.005 inch to 0.010 inch of the finished size, according to length, and carefully hardened.

As plugs require extreme hardness, it is only necessary to reheat them sufficiently to relieve the strain after hardening, excepting those of slender diameter, which should be drawn reasonably low—about spring temper—at the intersection of the shank and body, to prevent them from snapping off while inserted, should any side strain be exerted on the handle. With the use of a little fine emery mixed with sperm or lard oil applied to a simple cast iron or copper lap, pointed similar to a lathe center, and held in the chuck of a hand lathe, the centers are then lapped preparatory to grinding.

The three most desirable results in grinding are straightness, smoothness of surface, and closeness to finished size.

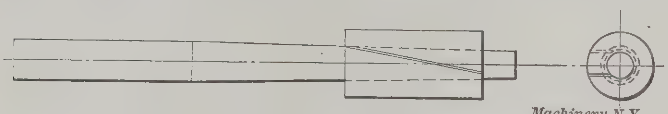
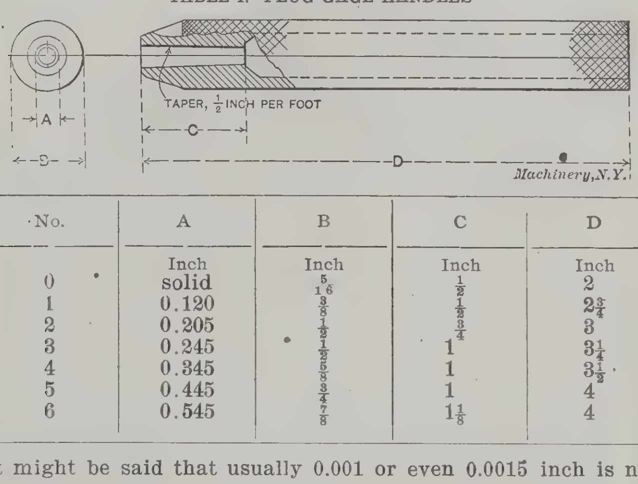


Fig. 7. Design of Lap and Lap Arbors for Making Ring Gages

When a good regular grinder is available the best results can be obtained, particularly if it is equipped for wet grinding; for then a piece can be ground to within 0.0002 inch of the final size, with the assurance of a perfectly smooth and even surface. An emery wheel of about No. 80 grade, with the cutting surface reduced to 1/8 or 3/16 inch in width, and kept from glazing or clogging, gives very satisfactory results.

For the benefit of those wishing to do work of this kind, and not having a regular grinding machine at their disposal,

TABLE I. PLUG GAGE HANDLES



No.	A	B	C	D
	Inch	Inch	Inch	Inch
0	solid	5/16	1/2	2
1	0.120	3/8	1/2	2 3/4
2	0.205	1/2	3/4	3
3	0.245	1/2	1	3 1/4
4	0.345	5/8	1	3 1/2
5	0.445	3/4	1	4
6	0.545	7/8	1 1/8	4

it might be said that usually 0.001 or even 0.0015 inch is not too much allowance for lapping when the work is ground in a bench lathe or other contrivance not made specially for this work. Under such conditions it is difficult to get any but a rough and uneven surface. Before grinding, the piece should be looked over carefully for cracks; those not discernible on the closest scrutiny will make their presence known in the process of grinding or lapping, but at whatever stage they develop, the piece should be immediately scrapped. Should the piece develop a tendency to run eccentric after the surface has been once trued or cleaned up by the grinding wheel, it evidently is cracked.

The object of lapping work after grinding is to give the extreme smoothness necessary to a lasting surface, and the minimizing of friction, and to correct any slight irregularities caused by the grinding wheel or due to imperfections in the grinding machine, as well as to perfect its straightness.

For plug and ring gage work, cast iron makes the best lap, and although it cannot be charged with abrasive as readily as copper or lead, it gives much better results, besides wearing much longer than the other metals. Laps for lapping plugs are made from disks ranging from 3/16 to about ½ inch in thickness, are drilled and reamed to a sliding fit on the ground plug, and split on one side to allow of adjustment, as shown in Figs. 3 and 4. The holders, made in a few standard sizes to accommodate the different disks, are of machine steel, knurled, and having three adjusting screws to enable the operator to regulate the tension of his lap.

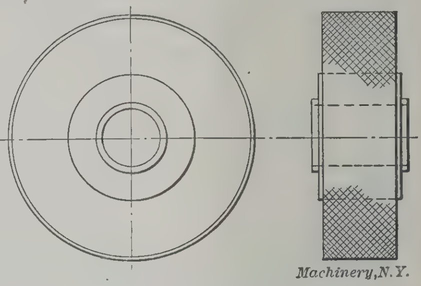


Fig. 8. Master Ring Gage with Small Collar at Mouth of Hole, which is ground off just before completing the lapping

The piece to be lapped should be running at the speed required in grinding, which varies according to diameter, and the lap adjusted at all times to grip firmly on the surface, but sufficiently free to allow its being held by the fingers. In the case of large work a wood clamp can be used. As the piece revolves, the lap is slowly drawn back and forth from end to end, and under no circumstances should this oscillation cease while the plug is in motion.

The proper abrasive to use in this operation is flour of emery, or a very fine grade of carborundum; the latter, being the faster cutter, seems more desirable. It is mixed with sperm or lard oil, to the consistency of molasses, and applied sparingly to the surface being treated, from whence it is taken up by the lap, which becomes charged as it passes over after each application.

As the operation is almost completed, however, this is discontinued, and a drop or two of oil charged with the finest particles of flour emery is substituted. This is obtained by sifting as from a pepper shaker about a tablespoonful of flour emery into a tumbler of lard oil, when, after standing an hour, the oil should be poured off, and will be found charged with the finest emery, the coarse particles having settled to the bottom. This abrasive is applied a drop at a time from the end of a small pointed stick or wire, and will make a remarkably smooth and bright finish. To the practiced hand, it requires very little time to lap a piece in this manner.

Should it be necessary to remove any quantity of metal by the lapping process, much faster methods can be employed, such as lead or copper laps charged with a coarse abrasive liberally applied; but the results will be found hardly satisfactory if accuracy is desired.

Should there be any hitherto undiscovered soft spots in the piece, they will invariably show up in the lapping, as their duller color is contrasted with the rest of the harder surface. However, it is possible for a piece to be slightly soft throughout, and finish up uniformly bright, but the softness should be discovered by file or other test at an earlier stage. In either case the piece can only be rehardened, and reworked for some smaller size, as a plug gage with a soft spot on its surface is useless.

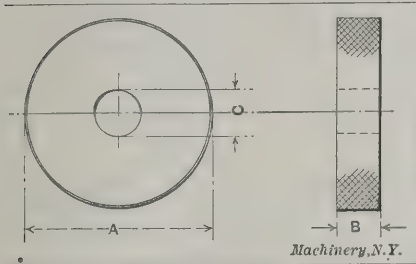
Ring Gages

When ring gages are to be made in quantity even when the quantity is small, they should be made from tool steel disks turned to certain standard diameters and cut from the bar. These blanks can be kept in stock, as well as the holders (see Figs. 1 and 5) into which they are forced after being drilled, reamed and hardened. The holders are made on a screw machine, of machine steel, requiring only to be turned, knurled, drilled and reamed with a slightly smaller hole than the diameter of the corresponding gage blanks, and cut off to length. They can be treated similarly to plug handles as to marking and bluing, as occasion demands; they can be used indefinitely by replacing the ring bushing when worn.

The gage blanks are drilled and reamed, or bored, to within 0.002 or 0.003 inch of the finished size, care being taken to have the hole as straight as possible. In handling for harden-

ing they are wired around the outside with a short piece of soft iron wire, to afford a means of handling and avoid the contact of tongs, or the necessity of passing a rod through the hole in dipping, as this latter has a tendency to cause bell mouth by retarding the action of the water within the hole. After hardening they are at once reheated sufficiently to relieve the strain, as in the case of plug gages. They are then ground on an arbor, allowing about 0.0015 inch to insure a tight fit in the holder, and are then rough lapped within 0.0005 inch of the finished size, pressed into place,

TABLE II. RING GAGE HOLDERS



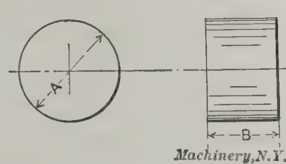
No.	A	B	C
	Inch	Inch	Inch
1	$1\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{16}$
2	$1\frac{1}{4}$	$\frac{5}{16}$	$\frac{7}{16}$
3	$1\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$
4	$1\frac{1}{2}$	$\frac{7}{16}$	$\frac{5}{8}$
5	$1\frac{7}{8}$	$\frac{11}{16}$	$\frac{7}{8}$
6	$2\frac{1}{8}$	$\frac{11}{16}$	$1\frac{1}{8}$

and finish lapped. The ends can be ground while on the arbor or on a surface grinder when in the holder, but before the finish lapping.

If the rings are sufficiently large to require grinding they should first be ground on the periphery to the proper diameter, and then on the inside to within about 0.001 inch of the finished size. As holes ground with a wheel are liable to be slightly tapering, they cannot safely be worked as close as a plug; in the grinding. It is an unnecessary expense to wheel grind rings up to ¾ inch diameter, as simple lapping gives equally good results and requires much less time.

The form of lap used (Figs. 6 and 7) is a cast iron cylinder with a taper hole, split diagonally on one side to allow of expansion as it is forced on a taper arbor, to compensate for the gradual enlarging of the hole being lapped. The lap should be about three times the length of the ring it is intended to be used in. The same rules regarding abrasive, speed, etc., apply as in the lapping of plug gages, but care should be exercised to avoid a too generous application of the abrasive as the process nears completion, for, if applied too lavishly the particles have a tendency to crowd under the edges and cause a bell mouth effect. This latter trouble is sometimes eliminated by making the rings with a slight

TABLE III. PLUG GAGE BLANKS



No.	A	B	C	D	No. of Handle
	Inch	Inch	Inch	Inch	
1	$\frac{1}{8}$	0.100	$\frac{5}{8}$	$\frac{3}{4}$ to $1\frac{1}{4}$	1
2	$\frac{3}{16}$	0.150	$\frac{7}{8}$	1 to $1\frac{5}{8}$	2
3	$\frac{1}{4}$	0.200	$1\frac{1}{4}$	1 to 2	3
4	$\frac{3}{8}$	0.300	$1\frac{1}{4}$	$1\frac{1}{8}$ to 2	4
5	$\frac{1}{2}$	0.300	$1\frac{1}{4}$	$1\frac{1}{8}$ to 2	4
6	$\frac{3}{4}$	0.400	$1\frac{1}{4}$	$1\frac{1}{4}$ to 2	5
7	$\frac{7}{8}$	0.400	$1\frac{1}{4}$	$1\frac{1}{4}$ to 2	5
8	$1\frac{1}{8}$	0.400	$1\frac{1}{4}$	$1\frac{1}{2}$ to $2\frac{1}{4}$	5
9	$1\frac{3}{8}$	0.500	$1\frac{3}{8}$	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
10	$1\frac{5}{8}$	0.500	$1\frac{3}{8}$	$1\frac{1}{2}$ to $2\frac{1}{4}$	6
11	$1\frac{7}{8}$	0.500	$1\frac{3}{8}$	$1\frac{3}{4}$ to $2\frac{1}{2}$	6

collar on each end (see Fig. 8), which is ground off after the rough lapping has been completed; but this is somewhat expensive, and except for master rings, hardly necessary.

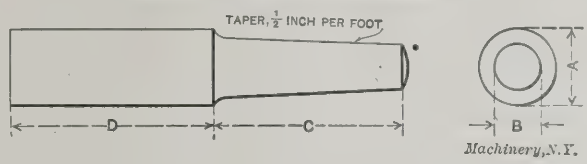
In the making of small ring gages which do not allow the insertion of a substantial cast iron lap, a tool steel lap charged with diamond dust can be used. This abrasive, which is not extensively used outside the watch factories and concerns doing work of like nature, must be used to be appreciated. It can be purchased as Brazilian bort, in a pebbly form; crushed in a suitable mortar, and graded to suit requirements; it is particularly applicable to hand or form laps, or laps for delicate or sharp corners. It is also a very rapid and smooth cutter, economical and lasting, and is readily taken up and retained on the surface of a tool steel lap to which a very small quantity is applied mixed with sperm oil, and rolled in with an extremely hard roll. Occasional rechargings are necessary as the work progresses, but in the intervals a drop of sperm oil is used on the lap.

Should it be required to make master or reference plug and ring gages, a somewhat different course should be followed than for gages intended for continual use. The method is about the same in each case, but with the former, after hardening, the work should be carried along at intervals, over a considerable time. First the rings should be cleaned up on the grinder and laid away, and later ground again, and so on during the course of a year, or even longer, where future requirements are being anticipated. This allows the metal to set, or as called by some, to season.

The Measuring and Fitting of Plug and Ring Gages

In factories not equipped with a measuring machine, some sort of standard should be adopted to which each and every workman can adjust his measuring tools. As few men measure alike, the disadvantages of varied adjustment are added, and the result is hardly conducive to uniformity. A first-

TABLE IV. RING GAGE BLANKS



No.	A	B	Finished Hole	No. of Holder
	Inch	Inch	Inch	
1	0.350	0.300	0 to 0.150	1
2	0.475	0.350	0.150 to 0.300	2
3	0.600	0.400	0.300 to 0.400	3
4	0.725	0.500	0.400 to 0.500	4
5	0.975	0.750	0.500 to 0.750	5
6	1.225	0.750	0.750 to 1.000	6

class gage maker has in his kit reserve micrometers, which are properly adjusted to the standard of his employer, and used only for reference or final measurements. This allows him to work to a remarkable degree of closeness before presenting his work for test, should a measuring machine be employed for that purpose; and where it is not, the work is usually inspected by one man, equipped with no better means of measuring than the maker's, but who serves to unify the element of touch which varies with different workmen.

Where master plug and ring gages are desired in pairs, the plug is first made to measurement, and the ring is then made and fitted to the plug. When trying the ring on the plug during the final fitting, both should be wiped perfectly clean and allowed to acquire like temperature, by lying together on a bench, or machine, or for a few seconds in cold water. The plug is then given a slight coating of rancid oil, and inserted in the ring, into which it should be a close wringing fit. When fitted properly this way, it will be found impossible to insert the plug, should the oil be removed, or even when some other kinds of oil are substituted. This rancid oil is simply the drippings of animal oil that has been used many times on some drilling or cutting operation; the older it is the better.

Should a number of plug gages of one size be required for manufacturing purposes, they should all be made to machine or micrometer measurement. It is utter folly to try fitting any quantity of plugs to one master ring if absolute uniformity is essential, particularly if they are of any considerable length, owing to the tendency of the ring to wear in the fitting. One of each lot can be tested to the ring to make sure that it conforms to the proper standard.

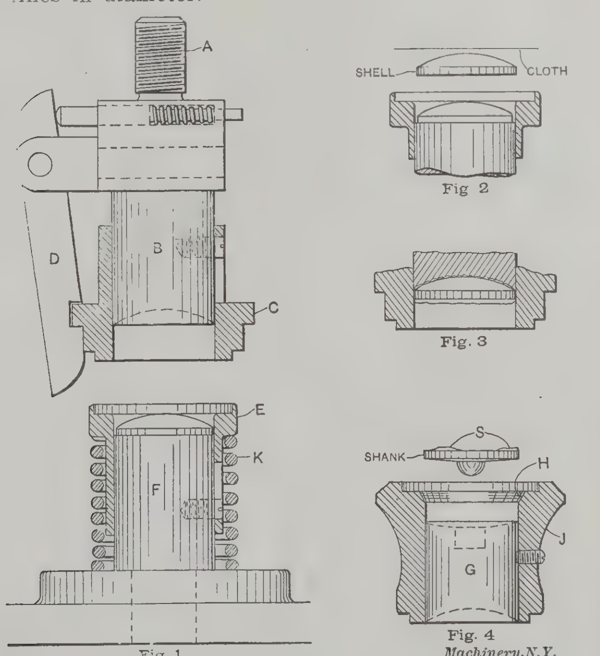
Ring gages, whether made singly or in quantity, are fitted to a master plug, which, as it wears, is comparatively inexpensive to replace, the wear being easily detected by occasional reference to the master ring.

DIES FOR COVERING BUTTONS

CHARLES WESLOW*

Charles Weslow†

The dies and tools used in the manufacture of cloth covered buttons are shown in the accompanying illustrations. The particular tools shown are for covering and binding together the two parts of what is known as a "fifty line unlined tablet button." One "line" on a button gage is equivalent to 0.025 inch or forty lines to the inch. The dies are used in a foot press of simple construction, this machine being adapted for this work. The ram of the press is tapped for the threaded shank *A*, Fig. 1. The case-hardened part *B* is finished to a diameter of 49¾ lines or 1.243 inch, and its lower end is concaved according to the style of shell or button. The sleeve *C*, which is bored 0.001 inch larger than part *B*, is made of machine steel and also case-hardened. This sleeve is supported by a lever *D*, during part of the time required for the covering operation, and it is provided with an elongated slot which fits the head of a small screw, as shown. Another case-hardened machine steel sleeve *E*, similar to *C*, fits over the part *F* which is likewise similar to the part *B* except that it is convex on the upper end to conform to the shape of the inner part of the button shell. This spring-supported sleeve *E* is the lower die. The diameter of *F*, except the small shoulder at the upper end, is 0.002 inch larger than the shell, the size of which depends on the thickness of the cloth used, which in this case is ¼ of a line or approximately 0.006 inch. This size shell is made of 36-gage stock. The largest bore of sleeve *E*, which is known as "the nest," is the same diameter as the cloth blank which is computed according to the style of the button. In this case it is 69 lines in diameter.



Figs. 1 to 4. Die and Thimble for Covering Buttons and Binding Shank and Collet together

The different parts of a button are shown in Fig. 5. The cloth blank in the upper left-hand corner of the engraving, covers the shell to the right, and this covered part is locked to the collet shown below after a piece of cardboard and canvas has been placed in position as subsequently described.

In Fig. 2 the shell and cloth blank are shown ready to be placed in the lower die. When they are in position the upper die descends and picks them up, as shown in Fig. 3. The part shown in Fig. 4 is known as a thimble. This thimble, which is of tool steel, acts as a closing or curling die, at *H*, and it not only curls the cloth between the shell and the shank, but it also closes in the shell thus binding or locking the two parts together. The radius of the surface *H* is found by experiment. The shank is shown in Fig. 4 ready to be placed in the thimble. When in position it rests on the plunger *G*, which is a sliding fit in the thimble. This plunger is prevented from dropping out by a set-screw, which engages an elongated flat spot on it. The largest bore of the thimble is the same diameter as the lower outside diameter of sleeve *C*, which is the same as the recess in part *E*, which, as stated, corresponds to the diameter of the cloth blank.

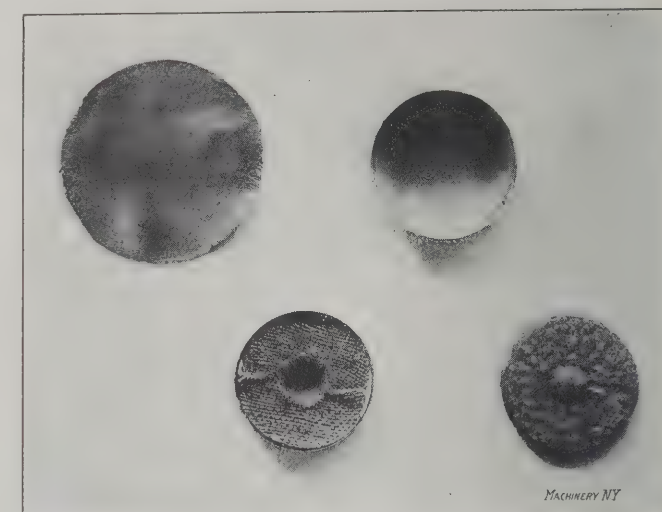


Fig. 5. The Parts of a Cloth-covered Button

Figs. 6 and 7 show the thimble in position for the second downward movement of the plunger. The thimble is put in place by hand after a shell and cloth cover have been picked up by sleeve *C* during the first stroke of the press, as shown in Fig. 3. The parts *C*, *J* and *E* are supported by the spiral spring *K*. When the upper die descends during the second stroke, lever *D* is disengaged from sleeve *C*, as shown in Fig. 7, so that the latter is free to move on part *B*, which continues to move downward when *C* rests on thimble *J*. In so doing, it forces the cloth cover to curl in as shown. Then the cylindrical part of the shell, which is now covered, strikes the curling section of part *J*, but the spiral spring now gives way to this pressure, so instead of the metal shell curling in as might be supposed, it acts in connection with part *B* to force thimble *J* down, which, in turn, acts likewise upon the sleeve *E*, which moves down until its lower end strikes the die-bed. By this time the shank will have entered the shell and carried the surplus of cloth cover with it. When sleeve *E* stops on the die-bed, part *B* continues to descend until the shoulder on it strikes the upper end of sleeve *C*; then there is nothing else for the invisible shell to do but curl in and embrace the shank, thereby locking them together and completing the button. Sufficient expansion takes place in the button, when the dies are released, to cause it to float on the top of the thimble. So it will be seen that two "kicks" or strokes of the press are required to cover a plain button.

In considering the manufacture of the five parts necessary in a plain button, we will first take up the shell and collet. These are blanked and drawn up in a combination die, known as a collet die, with a double action press, but not necessarily so. Stock of from 36 to 38 gage is used to make them, which comes in sheets of various sizes in much the same manner as tin. Some manufacturers get the 14 by 28-inch size and square shear them in half for convenience. The material used for shells is given a thin coat of japan to prevent rusting, but the material used for the collets is japanned black for appearance.

The stock is fed by hand up to a knife-edge stop, which is instrumental in separating the scrap stock from the sheet.

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† Chas. Weslow was born in Harrison, N. J., in 1876. He began work at the age of 11 years, out of necessity, and since that time he has been employed in a great many machine shops and manufacturing establishments in the East, as machinist, tool-maker, and tool designer. In this journeying, he has acquired a broad practical experience, which has been supplemented by the correspondence and night schools. The following are a few of the numerous establishments where he has been employed as tool-maker or executive: Noble & Hunt, Newark, N. J.; Western Electric Co., New York; Sloan & Chase, Newark, N. J.; Domestic Sewing Machine Co., Newark, N. J.; F. H. Richards Engineering Co., New York; Pike Adding Machine Co., Orange, N. J.; American Calculating Machine Co., Newark, N. J.; Crown Button Co., New York; Hyatt Roller Bearing Co., Harrison, N. J.; Premo-Hall Novelty Works, Newark, N. J.

The edge of the stock, after one row of blanks has been cut, is made up of half-circular forms, as shown in Fig. 8. This rough edge, however, is placed against the gage on the press when blanking to the succeeding rows, to guide the stock as it is being fed through, the gage being long enough to make it easy for the operator to hold the stock squarely against it. The press runs about 250 revolutions per minute, and the shells are blown from the die by a strong air blast. Some use an inclined press, relying upon gravity to remove the shell, but an air blast does the work quicker, thereby allowing a speedier action of the press. This blast comes through a 2½-inch tin pipe, which is nozzled at the die. After the first row of blanks is cut from the new edge of

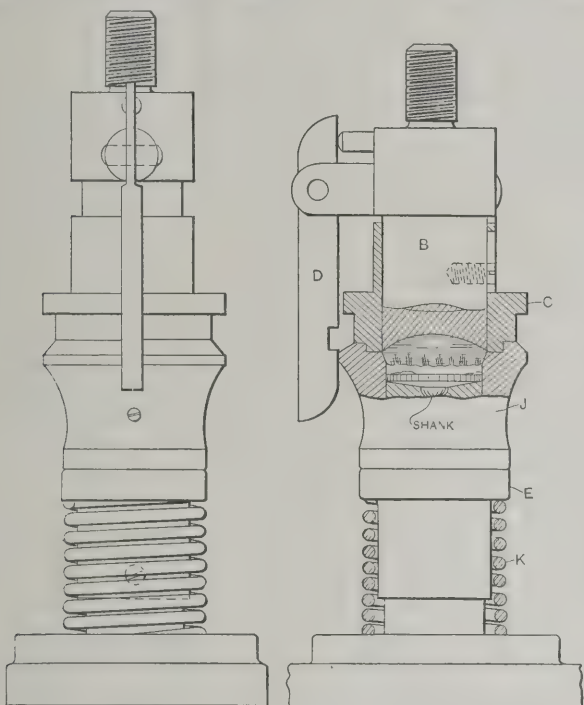

Fig. 6 Fig. 7 *Machinery,N.Y.*

Figs. 6 and 7. Die shown in Fig 1, with Thimble, Fig. 4, in Place

stock, the operator snips off the corner with a pair of scissors to prepare the stock for blanking the next row of holes. By carefully trimming the corner, the stock is so located by the knife-edge stop *S*, Fig. 9, that the blanks are cut as indicated by the dotted lines in Fig. 10, which, of course, effects a considerable saving in material. The first blank is cut singly to locate it properly and then the balance are cut out at a speed depending on the speed of the press. By referring to the engraving, Fig. 10, it will be noticed that no stock remains between the blanked holes. As the stock is fed forward a knife-edge stop effects a separation of the scrap from the sheet.

Another part to the button is the cloth cover. These are cut with a hand punch, which looks like a large size belt

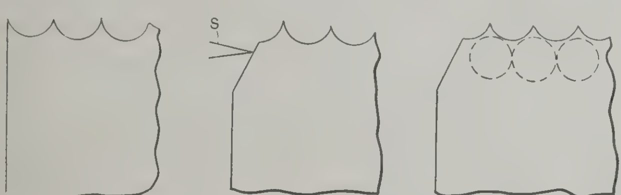

Fig. 8 Fig. 9 Fig. 10 *Machinery,N.Y.*

Figs. 8 to 10. The Way the Stock is located with Reference to the Stop to effect Economical Blanking

punch, and a mallet on a hardwood block. Several thicknesses of cloth are cut at one blow, and about ½ gross of the blanks are removed from the punch at one time. A good plan is to keep the cloth blanks in the position in which they are taken from the punch, in a receptacle for this purpose, instead of throwing them loosely into an open box. If the button is to be covered with a damask material, or fancy centers, as shown in Fig. 11, then the blanks are cut singly in a foot press.

The cardboard disks, which are inserted between the shell and collet, are cut on the single action power press in much the same manner as the shells are made, but they are forced through the die, while the shanks are knocked out. These "cardboards," as they are called, are rushed out "a mile a minute," no particular care being exercised, for if they crack or break, they are used anyhow, but they must be a certain

Fig. 11. Fancy Covers which are blanked singly

size to drive into the collet, to hold the canvas in position. The canvas pieces are blanked in much the same way as the cloth covers are. These parts are assembled in what is called a "machine," but it is in reality a light foot press built on the lines of general hardware.

Fig. 12 shows the style of die used in assembling the shanks. Two strokes of the press are required for each shank. The illustration also shows the shell and the canvas blank ready to be placed in the "nest." The punch *P* is shaped the same as an ordinary drawing punch, excepting the hemispherical projection provided at the end. This end is what forms the canvas stem which is sewed to a garment. In use, the collet is first placed in the nest with the canvas on top. The plunger then descends and forces the canvas into the pierced hole in the collet forming the stem. The lower end of the knurled ring *R* is turned to fit the recess in the upper end of part *Q*. This ring contains a plunger,

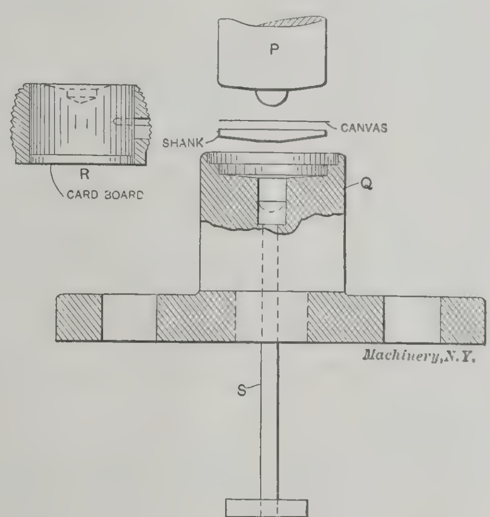

Fig. 12. Punch and Die for Forcing Canvas and Cardboard into the Button Shank

the top end of which is turned to fit the lower end of plunger *P*. The ring and its plunger are held together by a small dowel, as shown, which slides in an elongated slot in the ring. While the operator is forcing the canvas into place, this ring, which is held in the right hand, is being used to pick up a pasteboard disk, while the left hand secures another canvas and collet for the next button. After the first stroke of the plunger *P*, the knurled ring is inserted in the recess in *Q*. The second stroke, through the plunger in ring *R*, imparts a blow to the pasteboard, which is driven into the shank. The small plunger *S* is a simple form of knock-out for ejecting the shanks. Celluloid buttons are assembled in the same style die except that celluloid covers are first heated to make them pliable so they will curl and bend.

Good tool-makers are in demand for this work, and the writer knows of concerns who were offering $24 and $30 a week for competent men. As far as the writer knows, Williston of East Hampton, Mass., is the original covered button manufacturer, now known as the United Button Co.

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INVENTING AS AN OCCUPATION

From time to time our mail brings a woeful tale from a disappointed inventor who has devoted a number of years and considerable money to the perfecting of some device which the world has not duly appreciated. Many inventors spend years on the development of an idea which to them appears to be of great value. Often, too, they sacrifice the employment by which they earn their daily bread. It is but natural that the inventor who has thus devoted his time and perhaps all of his savings to the development of a new idea should be discouraged when he finds that he can realize little or no returns from his invention. As a rule he thinks that he has been unjustly treated by those to whom he has submitted his idea and often regards the manufacturer as an enemy because the compensation offered is from his point of view inadequate.

In many cases the inventor sees from one viewpoint only. He has not the advantage of wide experience and knows little or nothing of the costly organization necessary for marketing goods. Inventing should seldom be considered as an occupation to which a man can profitably devote all his time, except in cases where the inventor's genius is of an extraordinary degree. The inventors who succeed as a rule retain employment in regular occupations while they perfect their inventions during spare time, the inventions being incidents in their regular occupations, or by-products, as it were. When an inventor works under such conditions he is more likely to correctly estimate the value of his inventions, and not be bitterly disappointed because his inventive genius is not highly appreciated.

A man who has true inventive genius cannot help being an inventor, but he should avoid living in expectation that one brilliant idea will make his fortune and enable him to live ever after free from all pecuniary cares. The hope of "striking it rich" is a common fault of many inventors. If they must invent, let them content themselves with moderate returns for their ideas, placing each in the best market possible, but not feeling disappointed if a large fortune is not realized from an idea that to the inventor seems very valuable.

Advice is cheap and is generally disregarded by those who could best profit by it. But notwithstanding, we cannot help suggesting that inventors of ordinary ability should retain their regular occupations while developing their ideas. They will be happier and their chances for success will be greater than if they give up profitable occupations hoping to produce something which will make a large fortune. The trouble is that inventors as a class are a somewhat irresponsible lot to whom a steady job is distasteful. Steadiness of character and genius are rarely found combined in the same individual, and doubtless much that has been said here will be of little value to the class most in need of advice.

* * *

MACHINE SHOP INTERCOMMUNICATION

There is no trade or profession so closely identified with the development of new inventions as that of the machinist and the tool-maker. Embryonic ideas are gradually developed through a series of experiments with their assistance, and when the model is finally completed, the tools and machines for its manufacture have to be constructed. The position of the up-to-date machine shop, therefore, is of the first importance in industrial development. It is this importance which has made it absolutely imperative that the equipment of machine shops be of the highest type in labor-reducing machines and time-saving methods.

One of the many important time-saving devices developed within the past few years, which merits the careful attention of shop managers, is the automatic intercommunicating telephone. Its installation in a plant means that machine shop superintendents are no longer subjected to the many annoyances occasioned in the past by the crude methods of communication in use, such as unreliable hand-bells, buzzers, unsanitary speaking tubes, etc.

The very nature of the modern machine shop organization with its various departments covering a large ground area demands that some quick method of communication be installed that will put every department in close touch with any and every other department. It should not be necessary for the foreman of, say, the milling department to go to the foundry to ascertain why certain castings required for a rush order have not reached him. His time is too valuable to be thus wasted. Again, the shipping department, located perhaps in a remote part of the works, should be in as close touch with the superintendent as the drafting-room just outside his office.

The automatic intercommunicating telephone, of which various forms are now on the market, brings all the departments of the modern machine shop in close touch with each other without involving charges for attendants. With its use a higher standard of efficiency can be obtained, and almost all the benefits of personal interviews can be enjoyed without the necessity of leaving one's own department. The old walking-talking method of communication between the superintendent and subordinates may be abolished and the time thereby saved devoted to other details. Orders can be transmitted and received almost instantaneously, and mistakes practically eliminated, or at least reduced to a minimum on account of the facility provided for readily securing directions and checking up doubtful information. The telephone should not, of course, be used to transmit orders of which a record is required. All such orders, requisitions, data, etc., should be transmitted in writing only; but the telephone can be made a most valuable means for explaining points not clear in written communications or which perhaps need modification in some detail to fit a certain condition.

Another advantage of the telephone not unimportant is the ready means it gives for locating the superintendent or others who may be making a tour through the works. In a few moments all the stations can be called up if necessary, the desired persons located; and any communication transmitted or information obtained with promptness.

All the foregoing and much more is common knowledge in the works where the telephone is an indispensable fixture, but notwithstanding its manifest advantages we still find many plants, otherwise up-to-date, which are sadly deficient in modern means of intercommunication. The defect can be remedied at small expense, and the saving effected will soon more than pay the cost.

THE HUMAN ELEMENT

ANALYST

Among the potent factors that impel a manufacturing concern toward the goal of commercial supremacy, is one that is often overlooked, but more frequently ignored—the human element. Employers sometimes forget that there is such a thing as a moral law and that it does not pay to violate it, and some superintendents and foremen have been imprudent enough to take undue advantage of the recent industrial depression to enforce methods and policies vitally affecting the workman's daily life, without regard to the human element that enters into his makeup, and which of necessity must be reckoned with later on.

As a consequence the men usually "take it out" by giving the company a bad reputation among their fellow-workmen, and it is a fact that some of the concerns which complain of the difficulty of securing and keeping good men, owe their troubles largely to this cause. The reputation of a shop for being "white" or otherwise spreads far and wide, and good men usually know pretty accurately whether it is a desirable place to work in or not. This often materially affects the establishment concerned, especially when good men are scarce. Business men have their commercial agencies and reports for ascertaining the reputation and standing of other concerns. Workmen do it by a different, but just as effective a method, and the superintendent or foreman who thinks he can treat men unfairly and not suffer for it makes a great mistake. The foremen, especially, should always remember that they are the direct representatives of the firm to the workmen, and that the men base their opinion of the company largely upon their opinion of the foremen. The workmen's promotions and increases in pay depend upon the foremen's characteristics and knowledge; their daily life and career are subject to his control, his caprice and vagaries. The character and ability of the foremen affect the workmen more directly than any other factor in the shop organization, and as a result have a direct effect upon their efficiency and disposition toward the company. Of course there are always two sides to a story. Many of the complaints come from men who are chronic fault finders, and who never would be satisfied with any conditions, however advantageous; so that before giving credence to these reports; one should always be certain that the facts are substantiated by reliable evidence.

We often hear of the tendency of workmen to limit their output and effort, and of their neglect to work for the good of their employers. This is usually the complaint of the manufacturer who does not consider the human element of sufficient importance to merit his attention, and who refuses to put himself in the other fellow's place and to build up an organization along lines which would mean encouragement and inspiration to his employes.

Another factor of great importance in its effect upon the human element, is the question of handling men so as to get the most out of them without incurring their enmity.

Ignorance of details will sometimes cause the management of a concern to entrust the important position of superintendent to the man who can talk loudest and make the greatest show on a little knowledge. Such a man is apt to possess an exaggerated sense of his own importance, coupled with jealousy of those who suggest any improvement in method or process. Add to these failings surreptitious dealings with foremen and workmen, and you have three of the greatest causes of trouble in a shop, resulting oftener in a spirit of hostility than of cooperation between superintendent, foreman and workman.

It sometimes happens that a superintendent makes the serious mistake of ignoring his foremen to a certain extent in order to display his authority, and instead of entrusting the details of the work to the foremen, gives orders directly to the workmen; so that the workmen lose respect for and confidence in their foremen, and the latter become mere figure-heads, without any authority except in minor details. In some cases this is necessary because of the incapacity of the ordinary foreman, but it is always advisable when practicable to give instructions through the foreman, and if he is not competent to run his department without such assistance he should be replaced by one who is.

It frequently happens that a superintendent desiring to retain the full credit for an innovation, makes the mistake of refusing to confer with different members of his organization in regard to any suggestion they may be able to offer, and attempts to force his plans through. Such action usually meets with covert opposition. His assistants, perhaps familiar with some obstacle in practice which he has not considered, say nothing and allow the experiment to fail, "because they weren't asked." In this way the small jealousy that impels one man or group of men to underrate the work done by others, often works incalculable loss to the employer. The fact must be recognized that, nine times out of ten, the joint advice of several men conversant with a subject is superior to any plan developed from one man's brain.

In every organization there should be a head and a strong one; but singularly enough the method often adopted in manufacturing establishments is to place all the responsibility on one superintendent and neglect to surround and strengthen him with a body of efficient foremen, who might be advisers of great value. In adopting such a policy the management fails to recognize the great benefit to be derived from securing the advice of a number of the best qualified men upon important matters, and from giving the foremen an opportunity to show their value, which with most men means increased ability to handle the problems submitted to them.

In contradistinction to the method of management portrayed above, is the shop organized along lines that enlist the cooperation of the personnel, that develops the latent ability of each man; a shop where all plans are based primarily upon the human element of the men who are affected. The sympathetic support of the foremen and workmen *must* be secured. The best qualified superintendent will not achieve the degree of success that should be attained unless he is supported by the foremen, job-bosses and workmen. To enlist their support, they must be consulted frequently concerning the difficulties encountered, and encouraged to suggest ways of overcoming them; they must be made to feel that the methods are their own, and their interest in the work recognized. Thus difficulties will quickly disappear, and ways and means for overcoming unexpected obstacles will soon be discovered.

Nothing is more vital to the progress of an enterprise than that its executive force should work in unison. Then the balance of the shop will generally do likewise. Let there be discord and lack of harmony among the heads of a concern and there will be an instant lining up of forces in opposition, one against the other, which will cause the entire organization to disintegrate and lose much of its efficiency. The only cure is cooperation, since the work of each man is related to and interlaced with the work of all. The spirit of "getting together," if fostered, will be the chief factor in developing the strong men in the organization, and it should always be remembered that the habit of concerted action can be cultivated—gradually, perhaps, but easily—if proper attention is paid to it.

It must be conceded that the humanitarian, fair-minded policy of management is the greatest stimulus to the ambition of the workmen, and that a loyal, interested force of workers, impelled by a feeling of good fellowship to do their level best, constitutes the concern's best asset, and is the greatest and strongest factor making toward success.

* * *

It is evident that Bleriot's exploit in flying across the English Channel has stirred the imagination as has no land flight of equal distance, and that it has also greatly stimulated the progress and development of aviation.

The enthusiasts see in Bleriot's flight the beginning of a new era in which man will conquer the air, and in which the sea, "that parts nations asunder," will no longer be a hindrance to his movements. To us there is something essentially fine, heroic and conquering in the vision of the Frenchman's exploit; it shows man overcoming the seemingly insurmountable through his control of natural forces, made possible by the development of mechanical engineering. The machinist can rightly claim a large share in this latest triumph of mechanical flight.

THE TESTING OF FILES AND TOOL STEEL*

The following inquiry regarding files has been made not merely for the benefit of the file-maker, but quite as largely for the benefit of the buyer and user of files. The subject, therefore, is treated from the standpoint of a practical engineer without any special knowledge of file making.

The testing of files is accomplished by means of a special machine (see description in MACHINERY, December, 1907, engineering edition) which records the endurance and metal-removing qualities of the file on a piece of paper wound around a cylinder, thereby producing diagrams as shown in Figs. 1 and 2. In these diagrams the horizontal distances represent the number of strokes made by tne file tested, and the vertical distances the number of cubic inches of metal removed during the life of the file. The curves drawn in Fig. 1 show the life history of two files from the time when they were new until they were completely worn out. It will thus be seen, for instance, that one file removed somewhat

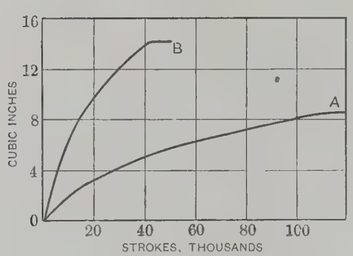


Fig. 1. Diagram resulting from File Tests on Steel, made on the Herbert File Testing Machine

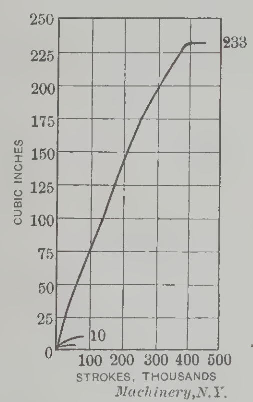


Fig. 2. Diagram resulting from File Tests on Cast Iron

over eight cubic inches of steel in 108,000 strokes, after which the file was incapable of removing any more metal. The other file removed the same amount of material in the first 16,000 strokes, and was still in good condition, removing a total of 14 cubic inches in 42,000 strokes before worn out. In Fig. 2 is shown even a more striking comparison, and here the great variation in the amount of work possible from files of different quality is exhibited. The two sides of one file removed 10 and 3 cubic inches, respectively, of cast iron before becoming too blunt to cut, while one side of another file reduced to filings nearly 20 feet of a cast iron bar one inch square before unable to cut. These examples indicate that file testing is a matter of considerable importance in shop economy, particularly in the assembling department where a great deal of time may be wasted by using inferior files.

The files are tested until they slip over the surface of the test bar without cutting, this condition being shown by the curves taking a horizontal course. Tests which are stopped before this point is reached may give a false impression as to the relative merits of files. It may happen that two files cut equally well during the first 50,000 strokes, and if the tests were stopped at this point the files would be considered equal. If the tests were continued, one file might cease cutting at 60,000 strokes, and the other continue for 400,000 strokes, thus showing a great difference in their durability.

Results and Conclusions of File Testing

Among the results obtained by the file-testing machine, perhaps none is of more interest than the discovery that the two sides of a file are seldom equal in efficiency and durability. Fig. 3 shows the curves for the two sides of the same file, one of which accomplished three and one-half times as much work and made four times as many strokes as the other. Such results are common. File-makers generally explain this difference as due to a variation in the sharpness of the chisel used in cutting the files. If a great variation is thus found between the sides of a file, it is likely that equally great variations will be found between individual files in the same lot, this being an evidence of lack of uniformity in the manufacturing process. One of the most important services, therefore, that is rendered by the file-testing machine to makers and users of files, is that of showing the great difference caused by minute variations in the shape of the file teeth, variations which can scarcely be detected by examination, and which can only be eliminated by extreme care in all the processes of manufacture.

It has been assumed that a file made of good steel is a good file. The teeth, of course, are expected to feel sharp, but beyond this very little attention has been paid to their shape. The file-testing machine has shown that the shape has a far greater influence than the quality of the steel, not only on the rate of cutting, but also on the amount of work that can be got out of the file. Fig. 5 shows the curves obtained from tests where five files were worn out at practically the same number of strokes (110,000). The amount of iron filed away varied very greatly. These variations in rate of cutting are more marked on cast iron than on steel. The best file in Fig. 5 cut when new at the rate of 14 cubic inches per 10,000 strokes, while the poorest file cut hardly more than ½ cubic inch during the same number of strokes, the material being cast iron. On steel a rate of 6 cubic inches per 10,000 strokes is rarely exceeded.

The rate of cutting is given by the slope of the curve and depends almost exclusively on the shape and sharpness of the teeth and on their relation to one another, and is not affected by the quality of the steel. As many files cut at a very slow rate when considerably worn, it is economical to reject files at a fairly early stage of bluntness.

Factors Determining Efficiency of Files

The chief factors by which the cutting efficiency of a file is determined are:

1. Sharpness of teeth.
2. Slope of the front face of the teeth, or rake.
3. Slope of the back face of the teeth, or clearance.

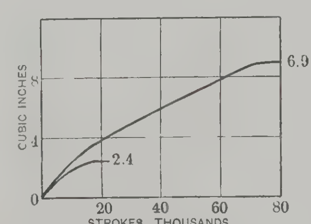


Fig. 3

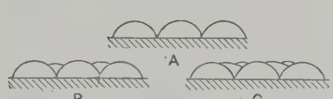


Fig. 4

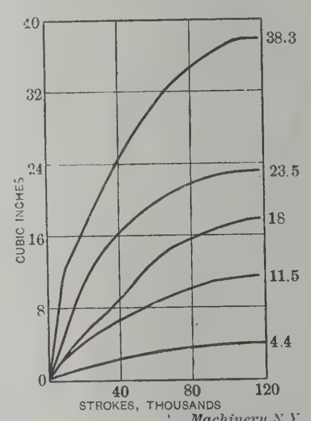


Fig. 3. Curves resulting from Tests of Two Sides of the Same File cutting the Same Material. Fig. 4. Arrangement of File Teeth, due to Variation in Ratio between "Up-cut" and "Over-cut." Fig. 5. Five Files of Equal Durability, but Unequal Capacity for Removing Metal

4 and 5. Angles of the two cuts relative to the axis of the file.

6. Pitch or coarseness of the cut.

7. Ratio between the pitch or number of cuts per inch in the "up-cut" and in the "over-cut."

At first sight it would seem that the sharpness of the teeth would be the most important factor in cutting efficiency, but the experiments indicate that this is not the case. Two files equally sharp, and thus cutting equally fast when new, do not show the same efficiency.

The slope of the front face of the teeth on commercial files as made at present is very rarely vertical, but in almost all cases there is a negative rake varying from 3 to 25 degrees. Experience with lathe and planer tools would lead one to expect that a tool with considerable negative rake would be exceedingly inefficient on almost all materials, and it is surprising that such a tool cuts at all under such light pressure as can be applied by hand on a file. Nevertheless it is a fact that files with considerable negative rake not only cut, but take off very satisfactory curled chips. The reason

* Abstract of paper by Edward G. Herbert, read before the Manchester Association of Engineers, March 27, 1909. For description of the file-testing machine referred to, see MACHINERY, December, 1907, engineering edition.

for this is probably that the file tooth is presented to its work at an angle, owing to the slope of the cut across the file. This gives a slicing cut, which probably accounts for this efficiency.

The slope of the back face of the tooth, or clearance, is very difficult to measure because it is not a plane surface, but the angle is very important in relation to the durability of the file. A file which is worn out has the tops of its teeth flattened or rounded. When the area of contact of the teeth with the work attains a certain value, great pressure is required to cause the teeth to "bite" the metal. The amount of work that can be obtained from a file, therefore, depends largely on the volume of teeth available for wear before this limiting area is obtained.

Examination of commercial files show that these angles are extremely variable, and it is certain that uniformly satisfactory results cannot be obtained unless correct angles are ascertained and maintained, leaving nothing for the variation of judgment on the part of the workmen. The pitch or coarseness of the cut does not seem to influence the efficiency of files to any great extent. Very coarse files, however, are almost always inefficient, probably because of the difficulty of raising very large teeth, which are at the same time sufficiently thin and sharp. Very smooth files, on the other hand, cut slower and do less work than those of somewhat coarser cut, but in some cases surprising results have been obtained from smooth files also.

It may not be generally known that the two cuts on a file differ in pitch. Suppose a file had 25 cuts in the chief or "up-cut." If it has also 25 cuts per inch in the secondary or "over-cut" a cross-section of the file would appear as at *A*, Fig. 4, each tooth standing immediately behind a tooth in the row in front, and all the teeth lying in straight rows parallel to the axis of the file. Such a file would leave on the surface of the work a series of furrows with ridges between them. Now suppose that there be 25 cuts per inch in the "up-cut," but the "over-cut" is made with 16¾ cuts per inch. Then the appearance of the cross-section would be as at *B*. Each tooth now lies opposite the space between the two teeth in the row in front. The teeth in the first row still make a series of furrows, and the teeth in the second row work on the ridges between these furrows, planing them off and leaving a fresh series of furrows, but the file would be inefficient because the ridge between any two teeth would be too large to be taken off at one cut by the teeth behind. If the number of teeth per inch in the "over-cut" is increased to 19, the effect will be as shown at *C;* the ridges between the teeth in the first row are divided between the teeth in the second and third rows behind. This subject of the ratio between the "up-cut" and "over-cut" is likely to be one of the most important factors in file efficiency, but it has not as yet been thoroughly investigated.

Efficiency of Files on Various Metals

It has generally been assumed that a good file is good for all classes of work, brass, cast iron or steel. Some difference of opinion on this subject has been expressed, and there has been a fairly general agreement that a file for brass should have the "up-cut" nearly at right angles to the axis, although this is by no means a general rule. In view of this a series of experiments was planned to ascertain whether there is one particular cut which is best for all metals, or whether each metal requires a special cut to produce the best results. For these tests a number of files were ordered from several makers who were asked to cut them in the manner which they considered most suitable for cast iron, steel, brass, and general work, respectively, each maker supplying a number of files for each purpose.

In the experiments each file was tested on brass, cast iron, mild steel, annealed tool steel and "normalized" tool steel, the last being subjected to heat treatment which would make it uniform in hardness throughout its length without actually annealing it. In one case a brass file gave the best result on brass, but this was the only instance where the best result on any metal was obtained by the file intended for that metal. On the test on cast iron, for instance, two files intended for steel cut more than three times as fast as the files intended for cast iron. On the "normalized" tool steel (not annealed) the cast iron file gave best results. The conclusions of these tests, therefore, showed:

1. The subject of files for specific purposes has practically received no thorough attention. As a rule, files cut for specific purposes gave poor results on the materials for which they were intended, and good results on materials for which they were not intended.

2. Files especially well adapted for any one metal did not give good results on other metals.

3. Files which showed average efficiency on all metals were rather inefficient on all.

4. The tests clearly show that the ductile metals, such as mild or annealed steel, are most easily worked with a sloping cut, which usually produces curled filings. Cast iron and hard brass require a much less sloping cut. Brass files, in fact, should have an "up-cut" almost at right angles to the axis of the file.

5. As a general conclusion, therefore, it appears that it would be advantageous to have files especially cut for various metals and keep them on the work for which they are intended. Most files intended to cut all metals are decidedly inefficient on them all.

It will rest with the user to make the first move in the matter. The file-maker is naturally reluctant to double or triple his stock and to make files for all the existing sizes, shapes and cuts in two or three distinct styles, suited to different metals. The difficulty may involve a slight increase in the price of files, but the increase in efficiency will be out of all proportion to the increase in cost.

Another evidence of the un-uniformity of files and the incomplete understanding of the subject, even by file-makers, is shown by the fact that sometimes files of two or three different qualities are sold by the same maker at different prices. In most, though not in all, cases where such files were tested, it was found that the cheapest grade gave the best result, and the most expensive the worst. This is probably explained by the fact that by a "good" file, the file-maker almost invariably means simply a file of expensive steel.

Most of the leading British file-makers are now investigating, with the aid of the testing machine, the various problems connected with file efficiency. This investigation is attended with special difficulty. Apart from the quality of the steel there are at least eleven important factors, all having an influence on efficiency: seven angles, the sharpness of the chisel, the force of the blow, the coarseness of the cut, and the ratio between the two cuts. It is possible to make an infinite number of combinations of these eleven variables, and an alteration in any one of them is likely to affect several of the others. The problem is, therefore, greatly simplified if a simple file tooth can be isolated and its cutting efficiency measured under constant conditions while progressive changes are made in its shape and in the angle of its presentation to the work.

A Tool Steel Testing Machine

The simplification of the problem mentioned is made possible by the use of a recently-designed tool steel testing machine.

The principle of the tool steel testing machine will be understood from the diagram, Fig. 6, in which *A* represents a tube of steel or other metal, suitably guided and rotating about a vertical axis, while its lower end rests on a fixed abutment *B*. A cutting tool *C* is held in a vise *D*. The vise is mounted on knife edges *E*, lying in the plane of the end of the tube. By means of a screw *F*, with a movable weight and scale, the tool can be caused to press upwards against the edge of the tube with any desired force, and cut it away with a turning action.

The tube is held in contact with the abutment *B* by means of a weight *G*, the downward pressure of which is always greater than the upward pressure of the tool. As the tube is turned away by the tool, it is fed downwards by the weight *G*, so that the end of the tube, though it is constantly being turned away, is constantly held in contact with the abutment *B*, and the point at which cutting takes place is therefore

stationary. A dashpot *H* is connected to the vise to prevent jarring or vibration.

Turning now to the illustration of the machine in Fig. 7, it will be seen that the tube is driven by a spindle, which receives its motion through cone and friction disk gearing, capable of giving it a wide and continuous range of speeds. A paper-covered drum, mounted beside the column of the machine, is driven from the spindle through worm and spur speed reducing gear. Vertical movements of the spindle are communicated through a fine chain to a pencil mounted on a vertical sliding bar.

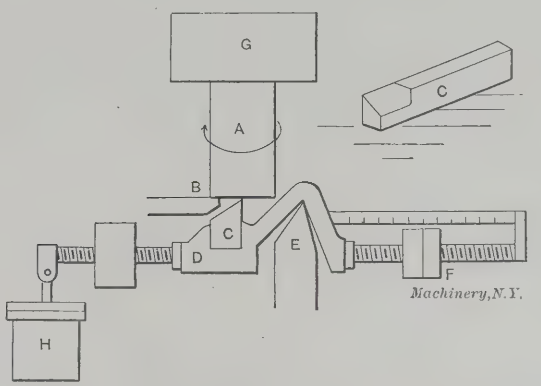


Fig. 6. Diagrammatical View of Action of Tool Steel Testing Machine

When the machine is set in motion, the pencil draws a diagram, in which horizontal distances represent the number of revolutions made by the tube, and vertical distances represent vertical movements of the spindle—*i. e.*, the length of tube turned off by the tool. The slope of the line at any point represents the rate at which the tube is being turned away, which is conveniently expressed in inches per 1,000 revolutions. In practice the tube is ¾ inch diameter and ⅝ inch bore.

By means of this machine it will be possible to ascertain what is the theoretically correct shape for a single file tooth for any particular metal. This information having been obtained, it will rest with the file-maker to ascertain by means of the file-testing machine what combination of theoretically correct file teeth gives the best maximum efficiency and durability to the file.

In the machine shown, the cutting of metal is reduced to its simplest and most elementary form. A straight cutting edge is pressed with a known force against a metal surface of constant width and unvarying hardness, moving at known constant speed, and being cut away at a rate which is graphically recorded. It is evident that the tool continues to cut until it reaches a definite degree of bluntness, when the pressure against the teeth will be insufficient to cause it to penetrate the metal. At this moment it will slip over the surface without cutting, and on the diagram this condition will be shown by the curve becoming horizontal.

Results of Experiments with Tool Steel Testing Machine

The results of these experiments are not, as yet, definite, but so far the results serve to show the character of the information that may be expected, and its bearing on the file tests. A series of tests made to ascertain the effect of variations in the clearance angle or slope of the back of the file teeth, with the front without rake, confirmed in a striking manner the condition that mere sharpness is relatively an unimportant factor in file efficiency. A second conclusion to be drawn from the tests is that the clearance angle has very little influence on the rate of cutting. The most striking feature of the tests is, however, the great difference in the duration and in the total amount of metal removed, showing that 0.05 cubic inch could be cut away with 5 degrees clearance in 100 revolutions before the tool ceased cutting, against 3.7 cubic inches of metal removed in 3,800 revolutions with 25 degrees clearance. Considering that all these tests were made with the same tool, the conclusion previously arrived at that durability of the file and the amount of work it is capable of doing depends far more on the shape of the teeth than on the quality of the steel is confirmed, and it would appear that the chief factor influencing the durability and output is the clearance angle or slope of the back of the teeth. The tests, however, indicate that there is a limit beyond which the clearance angle cannot be increased with advantage. When the clearance angle was greater than 25 degrees, the output and durability began to decrease. This was due to the fact that the edge of the tool broke away, indicating that the tooth was too weak; but it must not, therefore, be assumed that a clearance of 25 degrees is a practical limit. The tests were made with a pressure of 25 pounds, and this pressure applied to a single file tooth probably represents usage more severe than a file would be subjected to.

The results obtained also indicate how files of superior steel may give poorer results than files of inferior steel. In the case above, a tool of the same quality of steel removed in one case seventy-four times as much metal as in another case, the difference being merely a difference in clearance angle. Now it is a well-known fact that a high-carbon steel is much less ductile than one of less hardness. Consequently the high-carbon steel does not flow so readily when struck with a chisel; the burr which forms the working part of every file tooth is much lower, or in other words, the clearance angle is less. Thus it may easily happen that the extra durability of the steel is far more than counteracted by the lack of clearance, and a file of very good steel may give exceedingly poor results as a cutting tool if not properly cut with a clear understanding of the requirements of the durability and efficiency of files.

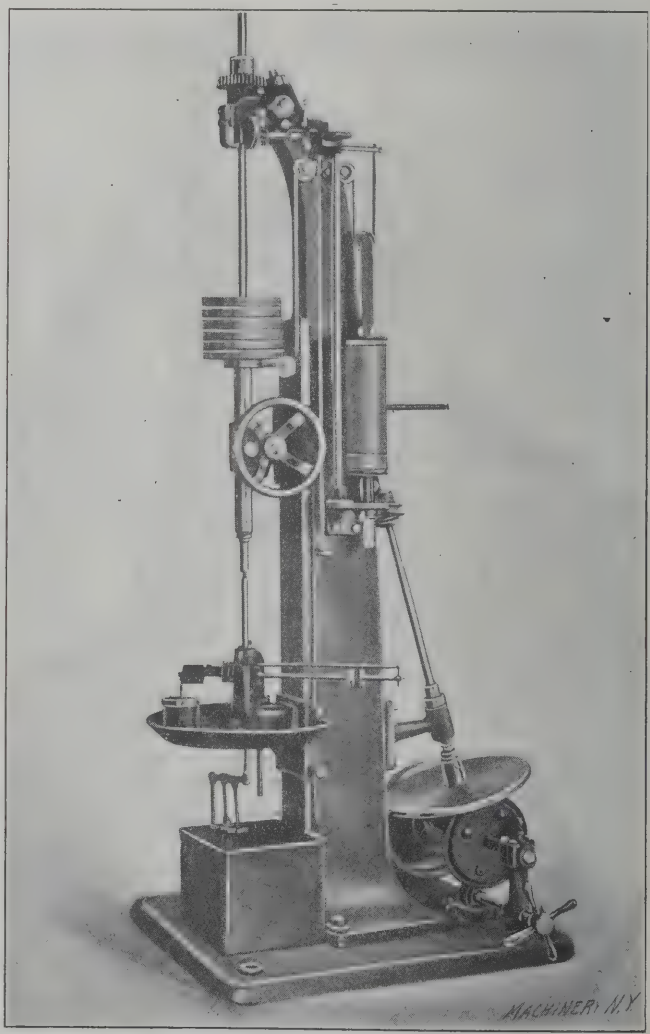


Fig. 7. Tool Steel Testing Machine

A series of experiments was made with a view to ascertaining the effect of varying degrees of rake and slope on the efficiency and durability of file teeth, the term slope being used to indicate the angle at which the up-cut lies across the face of the file. Only two slopes were experimented with —a slope of 90 degrees, corresponding to the cut of a file intended for brass, and a slope of 70 degrees, such as is commonly found in files intended for general work.

Each of these slopes was tested in conjunction with three different degrees of rake, *viz.*, a negative rake of 15 degrees, as commonly found in file teeth; a zero rake, the front face of the tooth standing at right angles to the surface of the work, a condition occasionally approached in file teeth; and a positive or forward rake of 15 degrees, a condition which is never found in file teeth, though experience with other cutting tools points to this as the correct form for cutting most metals. The same tool was used throughout, so as to eliminate any variations due to difference of temper or quality in the steel. Each test was made with a freshly sharpened edge, and was continued until cutting ceased. The pressure of the tool on the work was in all cases 25 pounds, the cutting speed 30 feet per minute, and the clearance angle of the tool 20 degrees in all except two of the tests.

The results of these tests showed that an extraordinary difference in the output of the work can be obtained in the same tool by a relatively slight variation in its cutting angles. Contrary to what might be expected, these variations have much greater effect on the output than on the rate of cutting. It was also noticed in these, as in all other tests made with the machine, that mere keenness of edge had very little effect on the efficiency. All the curves obtained were approximately straight lines, and cutting ceased abruptly with very little previous loss of efficiency.

Conclusions of Tests Relating to Shape of File Teeth

In relation to commercial file-making, the most important conclusion of the tests appears to be that the least desirable results of all were obtained with the tool which most closely resembled the commercial file tooth. The best results of all were obtained with a form of tooth which can probably be reproduced without great difficulty, but which appears never to have been adopted. This tooth would have a positive front rake of 15 degrees, and a clearance of 5 degrees. It was previously shown that the clearance angle is a most important factor in determining the total output and that the tool with no rake and only 5 degrees clearance will do only a very small amount of work, but it appears that a tool with the same clearance angle and with positive front rake will do an exceptionally large amount of work with great efficiency, and it is probable that by slightly increasing the clearance angle the output will be still further increased without undue weakening of the cutting edge.

Some caution will, of course, be necessary in applying the results just described to the art of file-making. These tests were made with what was practically a single isolated file tooth with a straight instead of a rounded cutting edge. The file is a series of round-nosed tools, lying very close together, and it may be found that a file with a positive rake will have a tendency to choke up with filings to such an extent as to neutralize its greater efficiency. The progress must be made by systematic experiments, confirmed at every step by the file-testing machine.

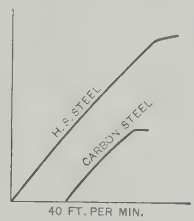
The results first described have a bearing on other cutting tools besides files. Of all the tool forms experimented with, among those that gave the smallest output of work was one having no front rake. This, however, is the usual form of tooth for milling cutters. There seems to be no reason for making milling cutters without front rake, except the well-known propensity of human beings to follow in their forefathers' footsteps. Milling cutters with front rake have been made and tried, and have given good results, and yet it is impossible to buy such cutters without having them made to order.

The Testing of Tool Steel

We now pass to the consideration of that function of the tool steel testing machine from which it derives its name and which may prove to be of greater practical importance than any other—the testing of the quality of tool steel. The slope of the curves produced on the diagram in the testing machine indicate the rate at which the test tube is being cut away by the tool point, and it is evident that this rate is governed by several factors: the speed and quality of the test tube, the shape and position of the tool, and the force with which it is pressed against the tube. Any alteration in any one of these factors will affect the rate of cutting and the slope of the curve, which therefore serves as an absolute check on the uniformity of the mechanical conditions. The remaining factor in the test is the quality of the steel, and a moment's consideration will show that this does not affect the rate of cutting at all. So long as a number of tools are equally sharp, they will all cut at the same rate under the same conditions, no matter what steel they are made of; but the tool which is made of the best steel will remain sharp longest.

The results of experiments on carbon steel and high-speed steel are shown in Figs. 8 and 9. At slow speed (30 feet per minute) the carbon steel lasted four times as long as the high-speed steel. At a somewhat higher speed (40 feet per minute), the high-speed steel tool lasted twice as long as the carbon steel. These tests were repeated, but the same results were obtained. Up to a certain limit all tools with increased speed not only did more work per unit of time, but lasted a greater number of revolutions. Another interesting experi-

Fig. 8. Comparison of Durability of Carbon and High-Speed Steels at Low Cutting Speed



Machinery,N.Y.

Fig. 9. Comparison of Durability of Same Steels at Increased Cutting Speed

ment was carried out with a blunt tool. It was tested until it ceased cutting at 40 feet per minute; when the speed was increased to 85 feet per minute the same tool immediately began cutting faster, that is, removing more metal per revolution than when it was quite sharp and working at a lower speed. This indicates that there is a definite state of bluntness corresponding to each speed. These are a few of the many curious facts that have been brought into prominence by the tool steel testing machine. They may or may not have an important bearing on the art of cutting metals, but it is necessary to bear them in mind.

The conclusions also throw an interesting light on the relative value of ordinary carbon and high-speed steels for various tools. For files, for instance, having a low cutting speed, it is likely that special alloy steels are of but little value. While it may not be assumed that all alloy steels are inferior to carbon steel for file making, it is evidently unsafe to assume that because a certain steel has given good results, say, for twist drills, it would be suitable for cutting tools used under totally different conditions. For instance, reamers are generally used for a slight scraping cut at a low speed, precisely under conditions for which high-speed steel seems to be least suited, and for such tools the high quality steel appears to be unwarranted. It may be too soon to dogmatize, but there seems to be reason for caution in the application of high-speed steel to the manufacture of such tools as reamers and milling cutters for light finishing work.

Another experiment showed that the maximum duty could be obtained from a carbon steel at the cutting speed of 50 feet, by a good high-speed steel at 85 feet, and from one of the new British high-speed steels at 140 feet per minute cutting mild steel. This latter result was unexpected, since no increase in the working speed was claimed by the makers of the new steel, but only an increase of durability at the speeds at which high-speed steel is ordinarily used. The tool steel testing machine can also be used for ascertaining the wear of metals, the efficiency of the various lubricants in cutting operations to preserve the edge of the tool, and for testing the hardness of metals.

The testing for hardness is accomplished by a drill loaded with a certain weight, and the rate at which it penetrates the material under investigation is used as a measure of hardness. This test is by no means new, but it has often been regarded with some distrust, because the sharpness of the drill is a variable factor in the result of the test as ordinarily applied. The production of considerable quantities of

test bars for the file and steel testing machines has called for some accurate method of judging hardness (using that rather vague term to denote resistance to the action of cutting tools), and the drill test has proved itself during nearly two years of continuous use the most sensitive and reliable test available.

The distributing influence of the varying sharpness of the drill is eliminated by adopting a definite rate of penetration on a standard reference bar. Suppose the rate of penetration of half an inch per 1,000 revolutions to be adopted, the load on the drill is adjusted until this rate of penetration is obtained on the standard bar. Tests on the materials under investigation are then made, and any variation in the rate of penetration, beyond certain predetermined limits, leads to the rejection of the material. Periodically a return is made to the standard bar, and any loss of penetration due to blunting of the drill is corrected by increasing the load. In practice a considerable number of tests can be made on ordinary materials without perceptible blunting of the drill. The sensitiveness of the test depends entirely on the rate of penetration adopted. A drill so lightly loaded as to be on the point of slipping gives a hardness test which is probably more sensitive than any other. In this connection it is interesting to note that drills of high-speed steel have proved quite unsuitable for the drill test, as they lose their sharpness much more rapidly than drills of carbon steel, under the extremely light cuts that are essential for a sensitive test.

The results put forward in the foregoing have been confirmed by repeated experiments, and are believed to be reliable as far as they go, but important facts may be undiscovered and those phenomena which have come into view may be only parts of larger phenomena which cannot be seen in their true perspective until they have been investigated from every side, and under widely varied conditions of experiment.

* * *

SIZES OF PIPE MAINS FOR HOT WATER HEATING*†

CHARLES L. HUBBARD‡

In the accompanying Supplement three sets of curves are given for determining the sizes of pipe mains for hot water heating. Two of the diagrams are for gravity circulation where the water is moved under a low head, the motion being due solely to the difference in temperature between the supply and return. The third diagram is made up for the usual range of velocity and head employed in forced hot water circulation actuated by means of a pump. In all cases the capacities are for pipe lengths of one hundred feet.

Volume of Water to be Moved

The volume of water to be passed through the supply main in a heating system may be found by the following equation:

$$G = \frac{E \times H}{8.3 \times (T - T_1)}$$

in which G = gallons per hour,

E = efficiency of radiating surface (170 for direct, 400 for indirect, and 1,000 for hot blast heating),

H = square feet of heating surface,

T = initial temperature of water (commonly taken as 180 degrees),

T_1 = final temperature of water (commonly taken as 160 degrees).

Example.—A heating system has 5,000 square feet of direct heating surface, and 1,000 of indirect; how many gallons of water (G_1) must pass through the main per minute, assuming a drop in temperature of 20 degrees?

$$G_1 = \frac{(170 \times 5{,}000) + (400 \times 1{,}000)}{8.3 \times 20 \times 60} = 125 \text{ gallons.}$$

* For additional information relating to heating and ventilation, see the following articles previously published in MACHINERY: Calculations of Fans and Heaters, June, 1908, engineering edition; The Heating and Ventilation of Machine Shops, September, 1907, engineering edition; and also the articles referred to in connection with the one last mentioned. See also MACHINERY'S Reference Series No. 39: Fans, Ventilation and Heating.
† With Data Sheet Supplement.
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Head to Produce Flow

The head to produce flow may be found by the equation

$$H = D \times h\, 0.000365.$$

in which

H = head in feet, producing flow,

D = difference in temperature between supply and return,

h = height or elevation of the heating surface above the boiler.

Example.—A certain quantity of heating surface is located at an elevation of 50 feet above the boiler; what is the available head for producing flow through the supply riser if the drop in temperature between the supply and return is 30 degrees?

$$H = 30 \times 50 \times 0.000365 = 0.55 \text{ feet.}$$

When the radiation is all on the same floor, the elevation h may be taken as the vertical distance between the center of the radiators and the center of the boiler. If it is equally distributed on several floors it may be taken as though it were all located upon the central floor.

If unevenly distributed, the *average elevation* may be found by the equation

$$h = \frac{A \times h_a + B \times h_b + C \times h_c}{A + B + C}$$

in which A, B, and C are the square feet of radiation upon the several floors, and h_a, h_b, and h_c the corresponding elevations of the radiators located upon these floors.

In computing the length of mains, provision must be made for the frictional resistance due to bends in the pipe. In practice it is customary to consider an elbow equivalent to increasing the length of the pipe 60 diameters, and a return bend equivalent to 120 diameters.

The size of main required to supply a heating system or group of heaters depends upon the square feet of radiation, the elevation above the boiler, the drop in temperature of the water in passing through the radiators, and the length of run. Taking the examples previously given, and assuming the length of the mains to be 200 feet, what size of pipe will be required?

Gallons per minute 125; available head to produce flow 0.55 foot. As the run of pipe is 200 feet long, the head per hundred feet is $\frac{0.55}{2} = 0.27$ foot. From diagram II in the Supplement we find that a flow of 125 gallons under a head of 0.27 foot calls for a pipe between 5 and 6 inches in diameter, in which case the larger size would probably be used.

Forced Circulation

In case of forced circulation the mains should be of such size that the total head required to overcome the friction will not exceed 50 feet, the usual range being from 30 to 50 feet. The velocity of flow is usually made from 5 feet per second in the smaller sizes (2 to 3 inches) to 10 feet per second in the larger sizes (6 to 8 inches).

The table in the Supplement gives the capacity of different sizes of pipe for varying velocities of flow through them.

* * *

In spite of their conservatism and proverbial "slowness," our British friends have achieved remarkable results in the running of fast trains, and on the Great Western R. R. results are obtained which are not equalled by any regular American service. Between London and Exeter, a distance of 174 miles, three expresses run daily without a stop, in exactly three hours, or at an average speed of 58 miles an hour. A fourth train on the same route makes the same run at an average speed of 56.3 miles per hour. It is not unusual for the total load back of the tender of these trains to be 400 tons.

* * *

The new radium institute of Great Britain has placed an order for a trifle over one-quarter of an ounce of radium-bromide, the price for which is not less than $150,000, or at the rate of $570,000 per ounce, or over $9,000,000 per pound. Some conception of the enormous labor involved in the extraction of this mineral is afforded by considering the price of a pound given as the wages of 15,000 men working one year of 300 working days at $2.00 per day.

THE COMMERCIAL AIRSHIP—A CRITICISM

FORREST E. CARDULLO*

In an article entitled "The Commercial Airship," in the August issue of MACHINERY, Mr. McCready reviews briefly the disadvantages of the heavier-than-air machines, and of the gas-inflated airships, stating that both are impractical for commercial work. As a substitute for them, Mr. McCready proposes a type of airship consisting in principle of a metallic reservoir of large volume from which air can be exhausted, lightening it by the weight of the air so exhausted. Obviously, if this contrivance is to be successful, the weight of the metal envelope must be less than that of the displaced air, and since the reservoir is to be exhausted of air, it must be strong enough to resist the external air pressure, which is 14.7 pounds per square inch or 2,117 pounds per square foot.

Now it follows that the material to use in the construction of this airship is that which has the greatest strength for a given weight. This material will be one of the alloy steels having high elastic limit and tensile strength. Aluminum is lighter, but is also weaker in much greater proportion. Many alloys of low specific gravity present advantages in certain types of construction, but pound for pound, they are not as strong as the alloy steels. Such alloy steels weigh about 480 pounds per cubic foot.

The form of reservoir which contains the largest volume within a given bounding area is the sphere. Consequently for a given volume and thickness of wall, a sphere will make the lightest reservoir. Also, since the compressive stress is the same in every cross section of the wall cut by a radial plane, the sphere will have the thinnest wall of any shape of the same diameter. It is apparent, then, that no lighter construction could be made than a perfect sphere without bracing. If the sphere is perfect, and the external pressure uniform, bracing is theoretically unnecessary, and no possible system of bracing can be devised which would make a sphere stronger for the same weight, than its theoretical strength, calculated on the assumption that it is perfect in form, homogeneous in material, and subjected to a uniform pressure. Hence if a spherical reservoir cannot be made light enough and strong enough to perform the desired service, no other form of reservoir will be possible.

Volume of 1 pound of air at 62 degrees F. and 14.7 pounds pressure per square inch $= 13.141$ cubic feet.

Volume of a sphere $= 0.5236\ d^3$.

Area of a sphere $= 3.1416\ d^2$.

Area of its great circle $= 0.7854\ d^2$.

Circumference of its great circle $= \pi d$.

Diameter of a sphere having a displacement of 1 pound of air at 62 degrees F. at sea level $= 2.93$ feet, which is found as follows:

$$13.141 = 0.5236\ d^3$$

$$d = \sqrt[3]{\frac{13.141}{0.5236}} = 2.93.$$

Its area will then be

$$3.1416 \times 2.93^2 = 26.97 \text{ square feet.}$$

Assuming that the steel weighs 480 pounds per cubic foot, and further that the shell will weigh exactly one pound, we find for the thickness of the shell

$$\frac{1}{26.97 \times 480} = 0.0000772 \text{ foot.}$$

or $0.0000772 \times 12 = 0.000926$ inch, or the thickness of our shell will be a trifle less than one-thousandth part of an inch.

The area of the great circle of this sphere will be

$$0.7854 \times 2.93^2 = 6.74 \text{ square feet,}$$

and the pressure upon it, at 14.7 pounds per square inch, is

$$6.74 \times 14.7 \times 144 = 14{,}270 \text{ pounds.}$$

The circumference of the great circle is

$$3.1416 \times 2.93 = 9.205 \text{ feet or } 110.5 \text{ inches.}$$

It therefore follows that the cross section of the shell on the great circle is $110.5 \times 0.000926 = 0.1023$ square inch.

The compressive stress produced in this cross section by the pressure of the air is therefore

$$\frac{14{,}270}{0.1023} = 140{,}000 \text{ pounds per square inch.}$$

Now it is obvious that we have hardly any substance sufficiently strong to construct such a sphere, and certainly there is no substance sufficiently strong to construct a sphere able to float in air and in addition lift 55 per cent of its own weight, when interior bracing is added to prevent collapse.

Mr. McCready states in his article that the vacuum system becomes proportionately more practicable and efficient as the size of the airship is increased. Let us see if this is true.

$$\text{Stress} = \frac{\text{pressure on great circle}}{\text{cross section at great circle}} = \frac{0.7854\ d^2 \times 14.7 \times 144}{3.1416\ d\ t} = \frac{529\ d}{t}.$$

$$\text{Weight of 1 cubic foot of air} = \frac{1}{13.141} \text{ pound.}$$

$$\text{Volume of } \frac{1}{13.141} \text{ pound of steel} = \frac{1}{13.141 \times 480} = 0.0001585$$

cubic foot.

Cubic feet of steel in shell $= 0.0001585 \times 0.5236\ d^3$.

Area of shell $= 3.1416\ d^2$.

$$\text{Thickness of shell} = t = \frac{0.0001585 \times 0.5236\ d^3}{3.1416\ d^2} = 0.000026\ d.$$

$$\text{or the stress} = \frac{529\ d}{0.000026\ d} = 20{,}300{,}000 \text{ pounds per square foot,}$$

and is independent of the diameter.

One point alone in regard to the construction advocated in the article referred to will serve to show its futility. The figures for a proposed vacuum airship are given as 150 feet diameter by 750 feet long. The weight of the cylinder, fittings and machinery is given at 270 tons. *If all of this 270 tons were utilized as a 700-foot steel column, keeping the ends of the cylinder apart against atmospheric pressure, the stress in the column would be 163,000 pounds per square inch.*

The truth of the above assertion may be demonstrated as follows: The area of a circle 150 feet in diameter is 17,671 square feet. On each square foot there will be a pressure of 2,117 pounds, or a total compressive stress, tending to force the ends together, of 37,400,000 pounds. Assuming the column to weigh 270 tons, or 540,000 pounds, its volume will be 1,125 cubic feet, and if it is 700 feet long, allowing for the conical ends, its cross section will be 1.6 square foot or 230 square inches. Now the stress in the column $= \dfrac{37{,}400{,}000}{230} =$ 163,000 pounds per square inch.

This stress looks rather excessive in a column 700 feet long. The following figures in regard to the stress in the walls, normal to an axial plane are, however, even more illuminating.

The strongest and lightest construction that we know of in the case of a cylinder subjected to external pressure, is that used in the Morrison corrugated furnace. The reason it is so strong is that the cylinder wall furnishes its own bracing. Let us suppose that the airship is built on this principle, and that the whole 270 tons is put into self-bracing wall. Then, the weight of cylinder wall per foot of length will be $\dfrac{540{,}000}{700} = 771$ pounds. This 771 pounds of metal will form a band around the cylinder $150\,\pi = 471$ feet long, and its volume, if of steel, will be $\dfrac{771}{480} = 1.6$ cubic foot. Its cross-section will then be $\dfrac{1.6 \times 144}{471} = 0.5$ square inch.

The total stress in this band will be one-half the pressure of the air upon 150 square feet (*i. e.*, the area of the projection of a section of the cylinder one foot long upon the axial plane) which is $\dfrac{150 \times 14.7 \times 144}{2}$ or 159,000 pounds. The stress per square inch is then $\dfrac{159{,}000}{0.5}$ or 318,000 pounds.

We are forced to the conclusion that no ingenuity of construction will make such an airship able to support even its own weight, unless we construct it of some unknown material having a strength many times greater weight for weight, than that of the strongest steel.

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BUSY MAN'S METHOD OF KEEPING A NOTE-BOOK*

JOHN S. MYERS†

Ideas unapplied to a useful purpose are worthless. A man's mind may be as full of ideas as a dog's fur of fleas and yet the man derive no more benefit from those ideas than the dog does from the fleas. Now the more busy the individual, the greater the number of ideas which crowd around the court of judgment crying for deliverance, and the greater the number of other people's ideas that are recognized as good; yet, at the same time, from the very nature of the case, the less time the individual has to devote to the useful

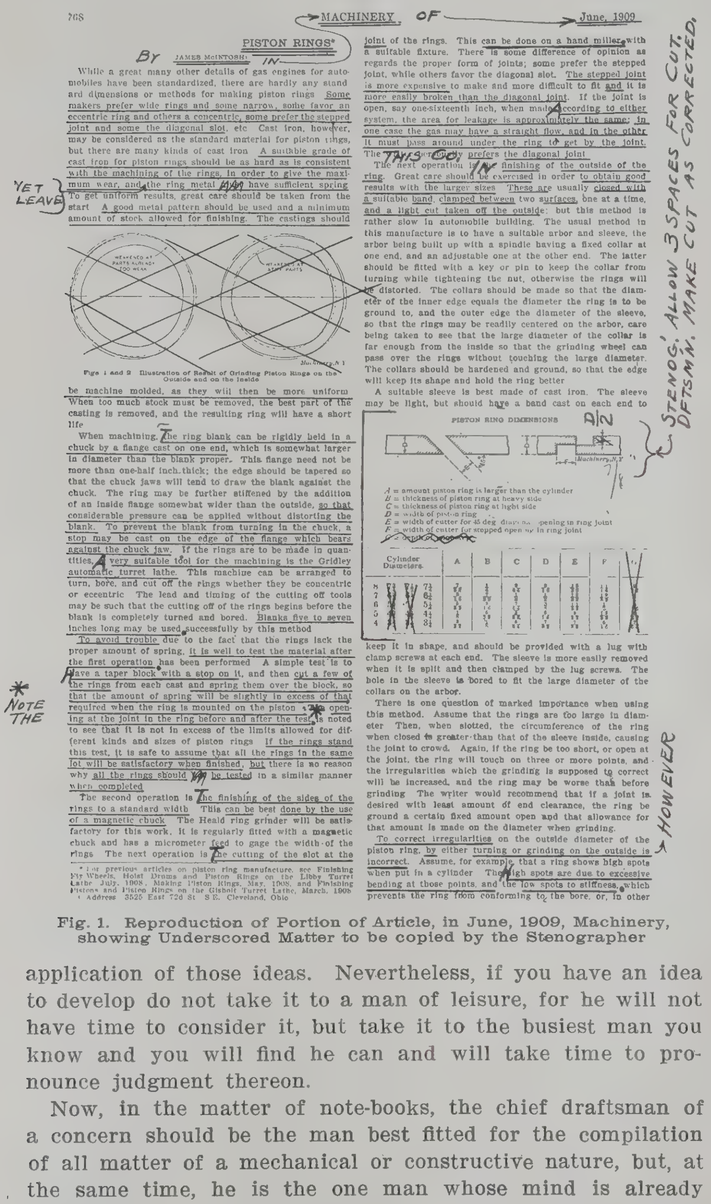


Fig. 1. Reproduction of Portion of Article, in June, 1909, Machinery, showing Underscored Matter to be copied by the Stenographer

application of those ideas. Nevertheless, if you have an idea to develop do not take it to a man of leisure, for he will not have time to consider it, but take it to the busiest man you know and you will find he can and will take time to pronounce judgment thereon.

Now, in the matter of note-books, the chief draftsman of a concern should be the man best fitted for the compilation of all matter of a mechanical or constructive nature, but, at the same time, he is the one man whose mind is already burdened with excessive detail; how, then, is he to do anything in this line? The answer obviously lies in the proper direction of efficient help.

The writer once worked for a large concern that employed a librarian; the librarian had charge of the vaults, storage and recording of all drawings, correspondence, trade literature, etc. It was the duty of the assistant librarian to conscientiously peruse all the trade magazines, catalogues, etc., in search of salient or pertinent information, and all such was clipped, pasted to cards, referred to the proper officer of the company and afterwards carefully filed. The magazines were all subscribed for in duplicate so that there was always an unmutilated copy on file to refer to for the complete text of an article any clipping was made from.

But most concerns would not care to go into the matter so extensively, and even those who could and would might find, as the writer did, many mountains in the way of best results. I therefore take pleasure in presenting to the readers of MACHINERY an inexpensive scheme for the busy man to compile a note-book in neat form with the minimum expenditure of his time and nervous energy.

The scheme as outlined is for the *very busy man;* for those who have more time to devote to it I would suggest that they simply do more of the work themselves and leave less to their help.

1. Direct that all magazines, catalogues, etc., be left on your desk as received.
2. Glance through each as received and mark or note any article of promise which you think may contain matter of especial interest to your line of work.
3. After so marking, throw the magazine or article in a box or drawer especially devoted to the purpose.
4. If the concern is very large have several of these boxes or drawers labeled *Mechanical, Structural, Electrical,* or any other classification that may suit your commercial conditions.
5. Instruct your squad bosses or specialists in various lines to dispose of the material in the following manner:
7. Squad foreman will at stated or convenient intervals go over all matter in his box or folder and carefully read all marked articles, and if he finds matter worthy of noting he will underscore the salient or pertinent matter with such corrections, notes, etc., as will enable a stenographer to transcribe same in a condensed form.
8. The stenographer will typewrite the underscored matter on standard loose leaf note-book paper, using a black ribbon and a sheet of carbon paper *reversed,* so that blue prints may be made.
9. The squad foreman will read over such transcribed matter and make any necessary corrections.

PISTON RINGS

By James McIntosh in MACHINERY for June 1909.

Some makers prefer wide rings and some narrow, some favor an eccentric ring and others a concentric, some prefer the stepped joint and some the diagonal slot. A suitable grade of cast iron for piston rings should be as hard as is consistent with the machining of the rings, in order to give the maximum wear, and yet leave the ring metal with sufficient spring. A good metal pattern should be used and a minimum amount of stock allowed for finishing. The castings should be machine molded, as they will then be more uniform.

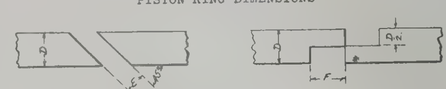
The ring blank can be rigidly held in a chuck by a flange cast on one end, so that considerable pressure can be applied without distorting the blank. To prevent the blank from turning in the chuck, a stop may be cast on the edge of the flange which bears against the chuck jaw. A very suitable tool for the machining is the Gridley automatic turret lathe. Blanks five and seven inches long may be used.

To avoid trouble it is well to test the material after the first operation. Have a taper block with a stop on it, cut a few of the rings, and spring them over the block, so that the amount of spring will be slightly in excess of that required when the ring is mounted on the piston. Note the opening at the joint in the ring before and after the test. If the rings stand this test it is safe to assume that all the rings in the same lot will be satisfactory when finished; but all the rings should be tested when completed.

The finishing of the sides of the rings to a standard width can be done by the use of a magnetic chuck. The cutting of the slot at the joint can be done on a hand miller. The stepped joint is more expensive and is more easily broken than the diagonal joint. According to either system the area for leakage is approximately the same; in one case the gas may have a straight flow, and in the other it must pass around under the ring to get by the joint. This company prefers the diagonal joint.

In finishing the outside of the ring care should be exercised to obtain good results with the larger sizes. These are closed with a band, clamped between surfaces, and a light cut taken off the outside.

PISTON RING DIMENSIONS



A = amount piston ring is larger than the cylinder
B = thickness of piston ring at heavy side
C = thickness of piston ring at light side
D = width of piston ring
E = width of cutter for 45 deg. diagonal opening in ring joint
F = width of cutter for stepped opening in ring joint

Cylinder Diameters		A	B	C	D	E	F
8	7-1/4	7/32	1/4	9/64	9/16	15/32	11/16
7	6-1/4	3/16	7/32	1/8	1/2	13/32	19/32
6	5-1/4	5/32	3/16	7/64	3/8	11/32	1/2
5	4-1/4	1/8	5/32	3/32	5/16	9/32	13/32
4	3-1/4	3/32	1/8	5/64	7/32	7/32	5/16

To correct irregularities by turning or grinding on the outside is, however, incorrect. High spots are due to excessive bending at those points, and low spots to stiffness. If we reverse the method and grind on the inside the irregularities will be corrected, for these stiff portions will become weaker and tend to bend more and the stresses in the ring will be equalized.

The table gives piston ring dimensions based on experience. The width D may be increased in wearing surface, but tabulated dimensions give satisfactory results. The inside of the ring should always be machined. The practice of annealing ring blanks does not seem desirable, as stresses due to cooling are remote with a ring blank of uniform thickness.

Fig. 2. Reproduction of Note-book Page, showing the Form in which Condensed Matter appears. Typewritten on Thin Paper with Carbon reversed on Back, thus making Copy that will blue-print well

10. The boy in charge of the note-books will see that blueprints of this matter are inserted in the several note-books kept in the office for general reference, and that special marked copies be delivered to foreman, etc., in charge of work upon which the articles especially bear.

To make the method perfectly clear I have selected at random an article in the June issue of MACHINERY, underlined it as would be done before passing to the stenographer. A reproduction of this underlined and noted article is shown in Fig. 1. In Fig. 2 is shown a reproduction (reduced) of the notes as transcribed by the stenographer.

* For articles previously published in MACHINERY on this subject, see "Envelope System for Filing Data," June, 1906, and "Binder for Preserving Articles of Special Interest," March, 1909.
† Address: 2456 Almond St., Philadelphia, Pa.

SIMPLE AND AUTOMATIC STOP-PINS FOR PRESS WORK

H. A. S. HOWARTH*

The stop-pin occupies a position of much importance among the accessories of the blanking die. Upon its design and adjustment depend both the quality and the quantity of the output of the press. Hence it is fitting that some attention be given to the consideration of it. By proper selection from the types to be described it is possible to secure a large output of blanks without recourse to more expensive apparatus. The several forms of stop-pins enumerated in the following list will be described in order, their proper uses being noted together with their merits and faults: The plain fixed stop-pin; the bridge stop-pin; the simple latch; the spring toe latch; the side swing latch; the positive heel and toe latch; the gang starting device.

These devices are capable of giving under the proper conditions, the maximum output of blanks. With the exception of the first, they can be used with either hand feed or automatic roll feed.

The ideal output of one blank for every turn the press can make in a day is never realized, with single dies. The delays

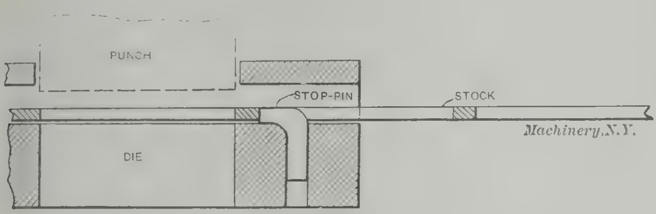


Fig. 1. A Plain Fixed Stop-pin

which arise from so many sources have to be studied carefully and eliminated so far as they contribute to unnecessary expense. In addition to improper design and poor adjustment of the stop-pin, other causes of small output are: Lack of skill; inconvenient arrangement of the new stock, the blanks and the scrap; inefficient methods of oiling the stock; and poorly made or poorly designed dies. A skillful operator, if given a little freedom, will usually arrange the stock distribution quite well, but the design and adjustment of the dies and the stop-pin usually devolves upon the toolmaker.

Plain Fixed Stop-pin

The plain fixed stop-pin, which is the simplest form, is indicated in Fig. 1. With it the operators become so expert that they are able for several minutes at a time to utilize every stroke of a press making 150 revolutions per minute. This stop is best suited to the use of strip stock in simple dies, because a miss will then cause no serious delay. The time between finishing one strip and starting the next affords the necessary rest for the operator. The concentration required is very intense—especially for the novice. When but a few blanks are made from a die at one time, and when changes of dies are frequent, this simple stop-pin is the most economical. Then too, it would not be feasible to use this stop-pin for coiled stock and expect the operator to finish the coil without

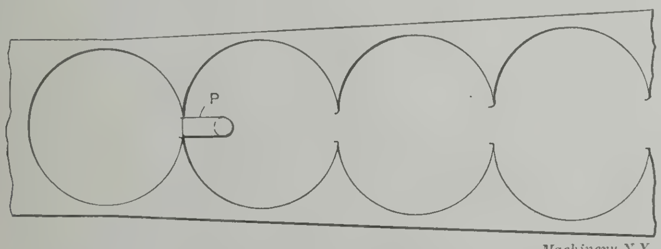


Fig. 2. Fixed Stop set close up to the Die so that there is no Stock between the Blanks

a rest or a miss. There is, however, one method of using this stop which permits of a maximum output: That is to allow no metal between the blanks. Then the stop-pin will extend clear up to the die and be high enough so that the stock cannot jump it. Each blank will then part the scrap at the stop-pin and allow the stock to be pulled along to its next position. This arrangement is shown in Fig. 2, with the stock parting at the pin *P*. This method is widely used on simple work where the edge of the blank does not have to be perfectly uniform. Where the die has least to cut it will wear away most on account of the thin pieces of stock that crowd down between the punch and the die. Small drawn cups are made in this way. The blank is cut by the first punch and held by it while a second punch, within the first, draws the blank through another die and forms the cup. This

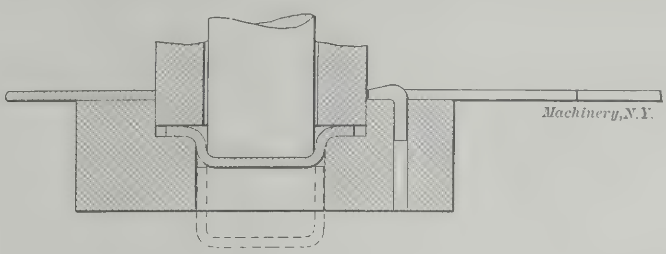
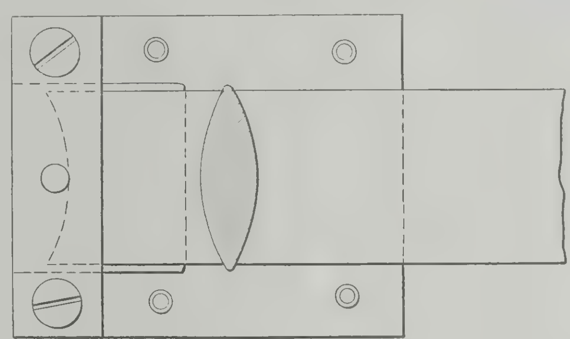


Fig. 3. Example of Work to which the Stop shown in Fig. 2 is adapted

is shown in Fig. 3. The stock feeds to the right and each cup, as formed, pushes the one ahead of it through the die as indicated by the dotted lines.

Bridge Stop-pin

The bridge stop-pin, shown in Fig. 4, is perhaps the most efficient and easiest to operate of all. It is also the simplest in design. The stop-pin *P* projects downward from a bridge *B* that extends over the stock which is being fed to the left. Provision is made for the blank (or scrap, as the case may be) to fall out under the bridge. Its use is limited, however, to that class of work which cuts the stock clear across and uses its edges as part of the finished blank. As here shown, the scrap is being punched through the die and the blank when cut falls down the inclined surface shown. When the



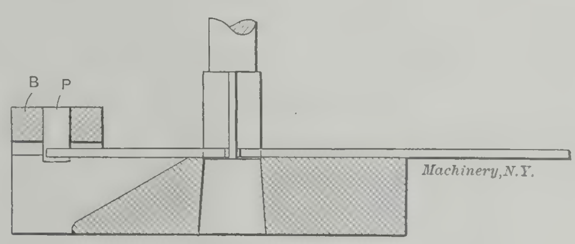


Fig. 4. The Bridge Stop-pin

blanks are simpler and have straight ends the die may be so arranged that each stroke finishes two blanks, one being punched through the die and the other falling outside down the incline. Little skill is required of the operator; he simply has to be sure to push the stock up to the stop-pin each stroke.

The Simple Latch

The simple latch is shown in Fig. 5. It is suited for dies that have pilot-pins. The latch is lifted by the down stroke of the punch and is lowered again as the punch rises. Hence it is evident that, if used with dies without pilot-pins, the punch must reach the stock and hold it before the latch lifts. When its lifting is thus delayed it will lower before the punch withdraws from the stock and will fall in the same place it lifted from. The stock will then not be fed along. But if a pilot-pin is used, it may be set so as to enter the guide hole just before the latch lifts. The latch may be set to lift before the punch reaches the stock. It will then fall after the punch withdraws from the stock, and sufficient time may be allowed for the operator to feed the stock along. This device is best

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suited for use with automatic feed rollers because the timing of the operations would be more uniform; whereas if the operator does not pull the stock with uniform speed the latch is apt to drop too soon or too late. Another manner of operating this simple latch is to give it its motion by means of a

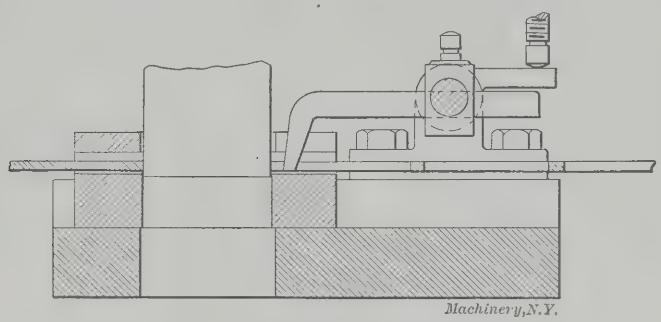

Fig. 5. The Simple Latch Form of Stop

cam or eccentric on the press shaft. When thus driven its motion can be very carefully timed, irrespective of pilot-pins. This style is also best suited for automatic roll feed. New presses are often provided with this attachment.

The Spring Toe Latch

The spring toe latch involves but little change from the simple latch. Fig. 6 shows it clearly with an enlarged detail of the spring toe. This latch may be used very successfully with hand feed and there is little danger of the stock getting

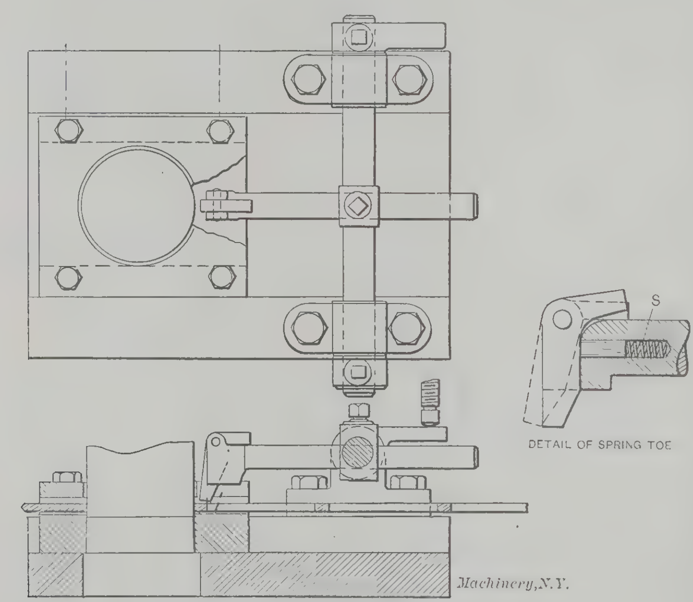

Fig. 6. The Spring Toe Latch Stop

by it too fast. Its operation is as follows: As the punch lowers and starts to cut the blank, an adjustable screw on the ram or punch plate lifts the latch. Its spring toe snaps forward and when the latch lowers, it rests on the scrap left between two blanks; hence it cannot fall back into its former place. When the operator pulls the stock along the latch toe drops into the next hole and brings the stock to a stop at the proper point, compressing the light spring S as it does so. This design is simple, rigid and effective. The spring toe here shown is preferable to the design which follows because it is light and requires but little tension on the stock to bring it to a stop.

The Side Swing Latch

The side swing latch is shown in Fig. 7 and it is but a modification of the latch shown in Fig. 6. When the punch descends, an adjustable screw hits lever L and lifts the latch. The whole rod R then springs forward till collar C stops against B. When the latch lowers it rests on the stock as did the spring toe latch. As the stock is pulled along the latch drops into the next hole and acts as a stop again. In this style the tension on the stock must be greater than with the spring toe latch because the whole rod R has to be pulled along against the spring Q until collar D stops against E. If this design were modified, however, so the side bearings would be used only for allowing the latch to swing, the toe could be constructed like the spring toe latch and would then be quite as effective as this type, though not so rigid.

Positive Heel and Toe Latch

While the two previous automatic stop-pins rely on gravity or a spring to bring them back in position, the heel and toe latch is positively operated. It is shown in Fig. 8, with the stripper removed. Its distinctive feature, which recommends it for use on a large variety of work, is that it is impossible for the stock to slip by it faster than one blank per stroke of the press. This is a very important matter when combina-

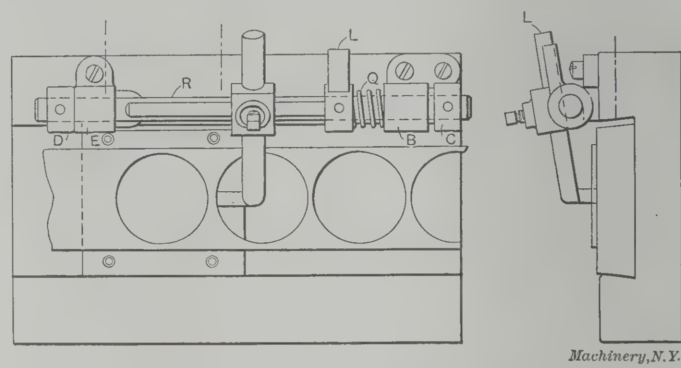

Fig. 7. The Side Swing Latch Stop

tion or gang dies are being used, because the pilot-pins so widely used require the guide holes to be punched just ahead of them. If the stock slips too far, the guide holes pass beyond the pilot-pins, and when the punch descends, the pilots punch their own holes, throw down a heavy burr and cause a delay—if nothing more serious.

Fig. 9 shows the catch in position to stop the movement of the stock at its point A. The stock is feeding to the right. The conical-pointed pin B is pushed by the spring S so that

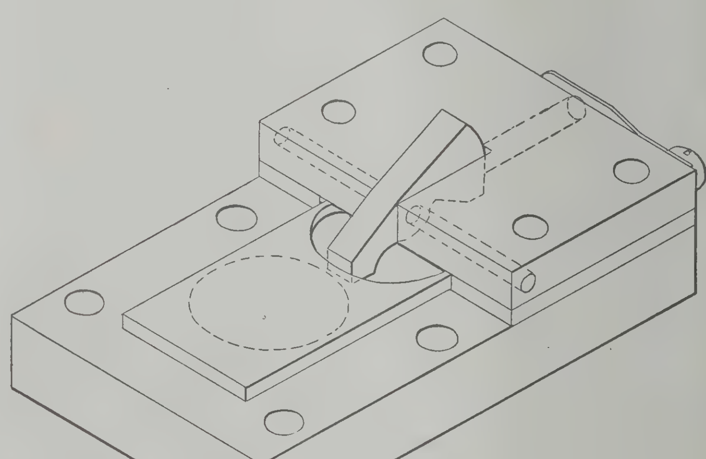

Fig. 8

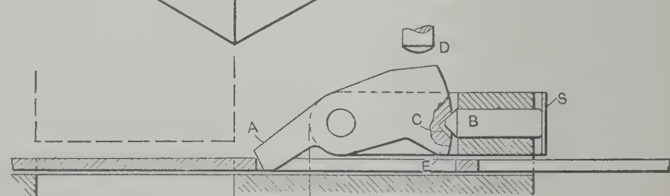

Fig. 9

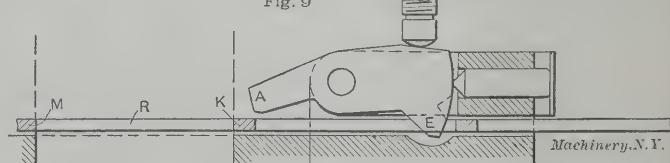

Fig. 10

Figs. 8, 9 and 10. Positive Heel and Toe Latch which prevents the Stock from moving more than One Blank per Stroke of the Press

it engages a conical depression C in the end of the catch. By this means the toe of the catch is pressed against the die. As the punch descends to cut the next blank an adjustable screw on the punch plate presses on the top of the catch at D and causes the heel to lower and the pin B to disengage the

notch *C*. The position of the catch is now shown by Fig. 10. Its heel *E* has been lowered into the hole left by the previous blank. It is held in this position by the pressure of the point of *B*. While this is sufficient to hold the catch in its new position, it offers but little resistance to its return to its original position. The stock may now be moved along. The metal *K*, left between two successive blanks, engages the heel *E* of the latch and lifts it easily. This causes the notch *C* to engage with the pin *B* and the catch snaps back into its first position. The toe *A* falls into the new opening *R*, and *M* comes to a stop against it. Since the metal *K*, between two successive blanks, cannot pass the heel of the latch without raising it, and since the heel *E* cannot rise without lowering the toe *A* far enough to catch the stock, it is evident that the action is positive. Hence the stock cannot jump ahead faster than one blank at a time. In constructing a stop of this kind care must be taken to allow under the heel *E*, Fig. 9, but little more height than the thickness of the stock. The length of the catch from toe to heel should be less than the opening left by one blank; then there will be no difficulty in starting the new ends of strips or coils. If necessary, however, the catch may be made so as to measure a little less than two or more openings in the stock. In such a case the catch would have to be tripped by hand until the first piece of stock *K*, between two blanks, had passed under the heel *E*. This would cause delays which would amount to considerable in the case of strip stock.

This style of stop-pin has been used successfully with gang dies cutting blanks from brass 1/32 inch thick, and cold rolled steel 1/64 inch thick. In the case of the steel blanks,

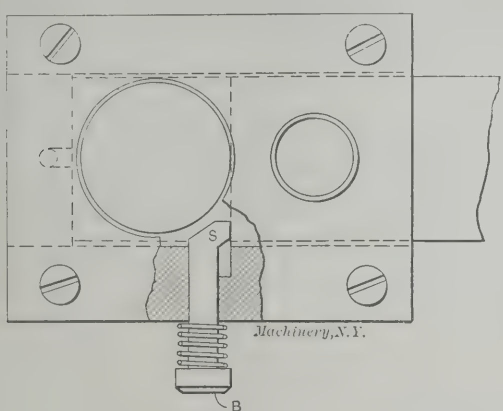

Fig. 11. Starting Device for a Gang Die

reels were used and the scrap was wound on a reel as it came from the die. By keeping the proper tension on the scrap, the stock was pulled through the die and kept against the stop-pin. Four thousand blanks per hour were made by this means. In view of the thin stock used and the fact that the dies were of the combination type, this was considered first rate. The stop-pin had to be set accurately because the thin stock prevented the pilot-pins from shifting it much in aligning it. Other precautions taken on account of the thin stock were to make the toe broad and to fit the stripper close to the front edge of the toe.

The Gang Starting Device

The devices so far described serve to stop the stock when it has passed the blanking punch. But there are many cases where two or more operations are performed on a piece before it reaches the blanking die and the usual stop-pin. The operator usually gages the proper positions by watching the end of the stock through openings in the stripper, but it is better to have temporary stop-pins that can be used for that purpose. Fig. 11 shows a starting device for a gang die with two punches. When starting a strip the button *B* should be pressed. This brings into action the temporary stop *S*, which locates the stock properly for the first operation. It is then released and springs back out of the way. The stock is then advanced to the regular stop-pin. As many of these side stops may be used as are necessary. Not only do they save annoyance and time, but they add to the life of the dies by preventing the partial cuts due to the stock entering too far at the start.

TWO FEED-STOPS OF WIDE UTILITY

C. W. D. AND W. B.

The authors make no claim of originality for the simple feed-stops here illustrated, nor is it desired to convey the impression that these stops are new or novel in their construction; experienced toolmakers will recognize them at once as "old acquaintances." There are certain points concerning

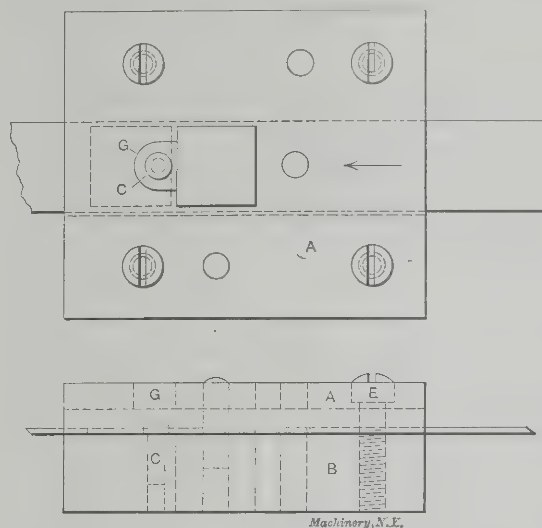

Fig. 1. Improved Form of Fixed Stop-pin

them, however, an explanation of which will be of benefit to those who are not experienced in punch and die work.

Fig. 1 shows a fixed stop-pin *C*, which is the most common of all feed-stops. It is the particular form of this simple stop to which we wish to call attention. The common way to make a fixed stop-pin is to bend over a piece of steel rod and drive it into the die. This appears simple enough, but we can say from experience that it is not so simple as it looks. As much as two feet of steel is sometimes used up in an attempt to make a bent stop-pin about one and one-quarter inch long. The difficulties and disadvantages connected with making a bent stop-pin are as follows: First, the difficulty of bending the pin at right angles without breaking it or bending the part to be driven into the die; second, after the pin has been made and hardened it is apt to break in driving it home to its place in the die because of its uneven shape; third, in driving the pin into the die it is apt to swing around out of its proper position making it necessary to knock it

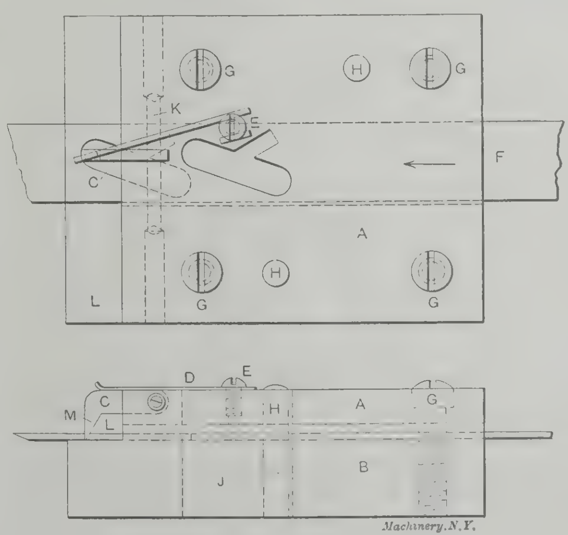

Fig. 2. Latch Stop-pin of Simple Design

around again and thus increasing the chances of breaking it. Every time the die is ground, this difficulty is experienced and the result is, frequent breakage and consequent loss of time in waiting for new stops. All these difficulties are overcome by making the style of pin shown in Fig. 1. This is simply a shoulder pin turned to a nice snug fit in the die. The shoulder, which acts as the stop for the stock, may be made

larger or smaller in diameter according to the width of scrap desired between blanks. This stop is quickly and easily made, is easily taken out and put back again after grinding the die, and it will last as long as the die itself. It is a good idea to cut a hole through the stripper *A* directly over the stop-pin as shown at *G* so that the operator can see the pin when the press is in operation.

The stop shown in Fig. 2 is excellent because of its simplicity, and also because of the great variety of work to which it may be applied. This stop is of the latch variety, but it differs from most stops of this type, in that it requires no mechanism to lift it. It is not operated by the action of the press nor by the punch, as is generally the case with latches. Its construction is simple. A hole is drilled through the stripper *A* to receive the pin *K* which passes through a hole in the stop *C*. The stop swings upon this pin. A light flat spring *D* is fastened to the top of the stripper so that the end of the spring rests on top of the stop. In securing this spring to the stripper, it is only necessary to place one end under the head of the screw *E* with a piece of the same material under the opposite side of the screw as shown in the plan view. By this method the spring can be quickly and easily attached or removed, and a straight piece of spring material can be used. The stripper, of course, should have dowel pins in it to insure its coming back in the same position every time the die is ground. The dowels and screws are shown at *H* and *G*, respectively. The stripper should also

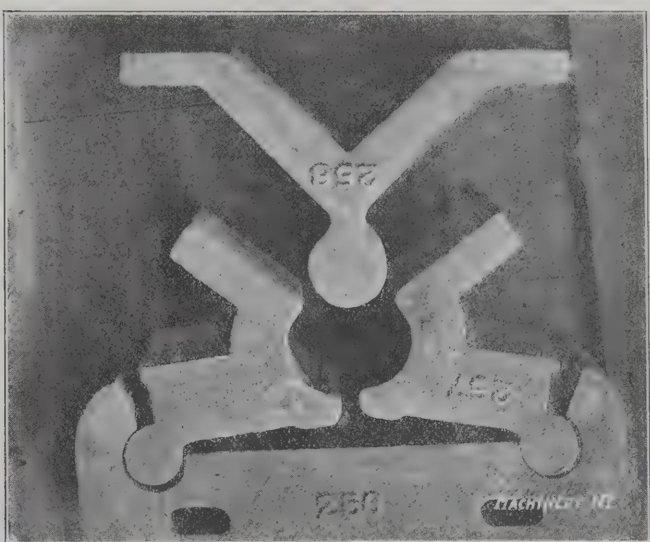

Fig. 1. Former for Making the Bracket shown in Fig. 3

be cut off at the stop end as shown at *L* so that the stop will be outside of the stripper and in full view of the operator. The action of this stop is as follows: The stock *F* is fed to the left, and as the punched strip passes the stop, the point of the stop *M* drops or rather springs into the hole made by the blanking punch. The operator then pulls the strip back against the straight outer edge of the stop, and holds it there until the next blank is punched. This process is repeated at each stroke of the press, the scrap between the blanks being pushed past the stop each time and then pulled back against it. The inner bevelled edge of the point *M* causes the stop to lift as the scrap between the blanks is pushed against it, while the outer edge, which is at right angles with the die, prevents the stop from lifting when the edge of the scrap is pulled back against it.

By this simple stop the operator can feed the stock at will without waiting for the operation of a mechanically-lifted stop, to say nothing of the time that is saved by not having to adjust an automatic stop. An operator, known to the authors, can make about 40,000 blanks per day with dies fitted with this form of stop on a press making about 100 strokes per minute. These stops are used only on hand-fed work.

* * *

Aluminum coins are to be circulated in France. The mint is ready to issue five and ten centime pieces of this metal. They will, of course, be much lighter than the ordinary coins, and have the advantage that they will not oxidize.

COMPOUND BENDING FORMS FOR THE BULLDOZER

ETHAN VIALL*

A short time ago, while visiting the shops of the Danville Car Co., at Danville, Illinois, the superintendent, Mr. H. C. Teipel, showed me several interesting bending forms which the shop foreman, Mr. A. S. Hesse, had made for use on their bulldozers. The forms shown in Fig. 1 are especially inter-

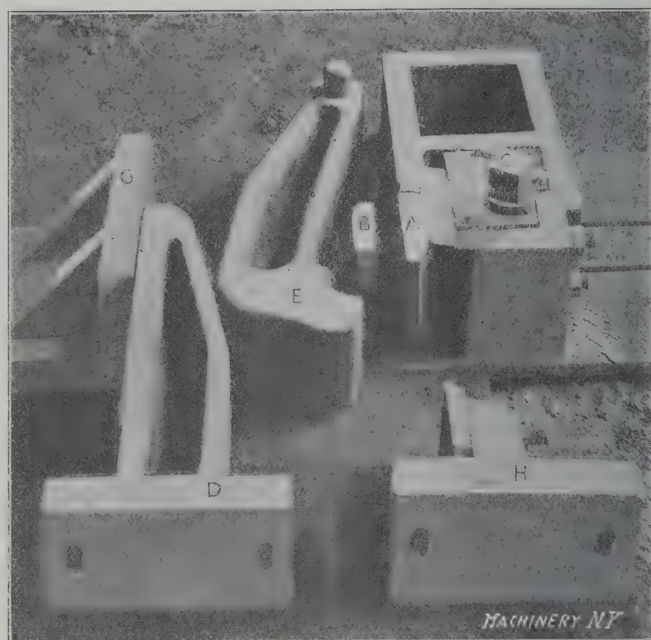

Fig. 2. Combined Former and Shear for Bending and Trimming the Gibs A, Fig. 4

esting from the fact that they were so cast that no machining was necessary in order to assemble them ready for use. Possibly a little filing was needed, or a small lump or two had to be knocked off with a hammer and chisel, but that was all. This device is intended to form the bracket, shown in Fig. 3, but a number of other brackets or hangers, can be made with formers constructed on the same principle. It will be noted

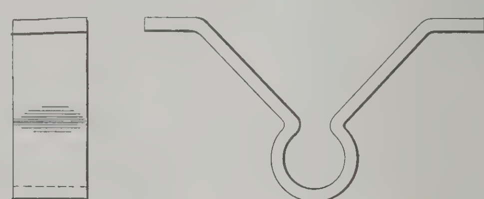

Fig.3

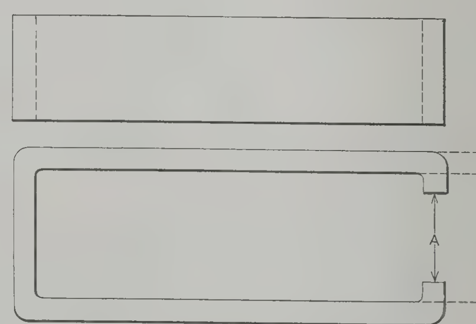

Fig.4 Machinery,N.Y.

Figs. 3 and 4. Pieces formed by the Tools shown in Figs 1, 2 and 6

that stops are cast on the back plate (which is the lowest in the illustration), against which stops on the wings of the pieces above strike, in order to locate them properly for the work. The planning of this former so that it would work just right, was not as easy as it looks at the first glance, and a study of its action will show several reasons.

A more complicated former is shown in Fig. 2. This former was made to bend and trim the drawbar-pocket gibs *A*, Fig. 4. In using this former the bar is placed between part *A* and

* Associate Editor of MACHINERY.

the clamp-jaw *B*, which is tightened by turning the eccentric *C*. The gib is now bent by the part *D*, which is fastened to the bulldozer ram, shoving over the gib-former *E*. During the bending of the gib, the part *D* is steadied and guided by the part *G*, which is bolted solidly to the bed of the bulldozer. The end of the gib is trimmed off by the shear-blade on part *H*, which slides past the outer edge of the blade on part *A*.

The adjustable male and female parts of the radius bender, shown in Fig. 5, are used to bend iron parts that would otherwise require about twenty different forms.

Fig. 5. Adjustable Bending Form

The draft-gear yoke-bender shown in Fig. 6, was made in the Ft. Wayne shops of the Pennsylvania Railroad and is only slightly different from those used elsewhere for the same purpose. The wings *A*, *A*, and the parts *B*, *B*, used to push them around during the stroke of the bulldozer ram, are all pretty well cored out to lighten them. The iron to be bent, is clamped between the form *C* and the sliding part *D* which is operated by the lever *E* turning an eccentric located in the block *D*. The yoke shown in Fig. 4, having straight ends as indicated by the dotted lines, is the product of this tool.

* * *

SPECIAL CENTERS FOR TAIL-STOCK

WALTER GRIBBEN*

The tubular shaft of tool steel, shown in section in Fig. 1, was so long in proportion to the diameter of the hole that it could not very well be turned on a standard bench-lathe arbor, and rather than make a special arbor of extra length, the tail-stock fixture shown in longitudinal and cross section in Fig. 2 was made to do this job. It has since proved remarkably useful on many other jobs, and is now considered a standard appliance in my bench-lathe outfit.

The body *A* is made of rectangular steel, with a 3/16-inch hole bored and reamed its entire length. The taper shank is turned true with the central hole, and fits the tail-stock spindle the same as an ordinary center. The binder *B*, and screw *C*, with the lever handle *D*, will hold any piece of 3/16-inch round stock, or any special piece with a 3/16-inch round stem, so that it will be in line with the live spindle.

For the job shown in Fig. 1, the plug *E*, Fig. 2, was made, the shank *F* being an easy fit in *A*, while the part *E* is ¼ inch in diameter at its outer end, and slightly tapering, so that it is about 0.001 inch larger on the inner end. The part *E* was hardened, tempered, and polished smooth, while the part *F* was left soft. This plug answered as a dead center for the end of the tubular shaft to run on while turning the outside. As a driver for the other end, a piece of rod larger than the hole in Fig. 1 was held in the live spindle and turned to a tight wringing fit in this hole. This left the outside of the work entirely free to operate on, including the turning of both ends at one chucking, which insured all the parts being true with one another. The slight taper on *E* provided for any fine gradation between a running fit and a tight fit to be obtained on the tail-center end, by adjusting the tail-spindle back or forward.

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In work of this character, no attempt is made to preserve the driving plug for subsequent jobs, as it does not need to be hardened, nor does it need to be polished. It is a comparatively easy matter to turn one up each time it is needed, and it is then sure to run true. They are generally made on the end of a stock rod, and after the job is completed, the driving rod is put back in stock. This, of course, is from the jobbing point of view, and not from a manufacturing standpoint.

The hardened steel plugs, similar to *E*, are made for each job as it occurs, and are preserved for future use. Fig. 4

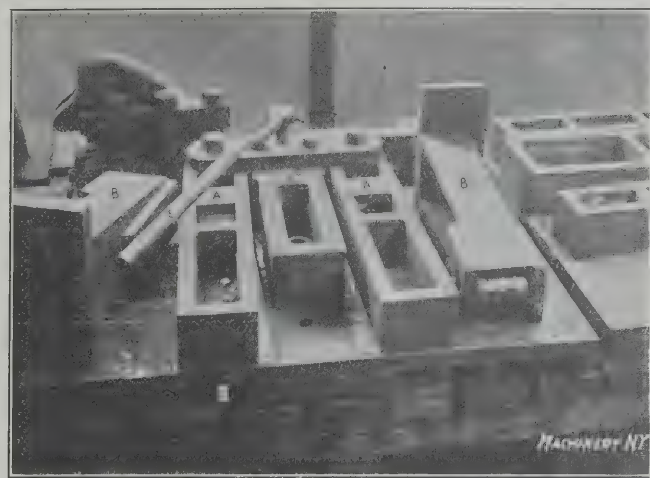
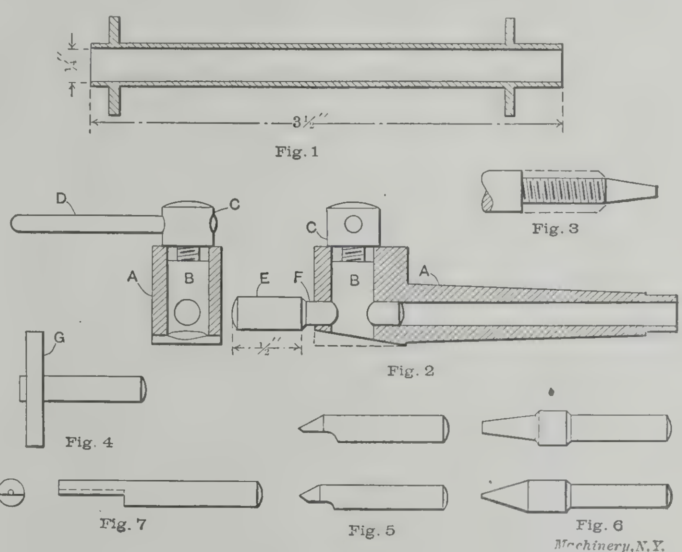


Fig. 6. Draft-gear Yoke Former

shows a sheet brass disk *G*, soft soldered onto a short piece of 3/16-inch wire, the edge of *G* being turned true after soldering on. This makes a convenient kind of center on which to run the end of a long piece of drawn brass tubing while truing the end, or cutting a thread on the outside.

Another use to which the tail-center, Fig. 2, is put is to hold short, stubby, flat drills for starting a true hole in chucked work. If the hole is in thin work, it may be drilled clear through with one of these flat drills, but if a hole has to be drilled in some distance, it may be started with one of the flat drills and finished with a twist drill.



Figs. 1 to 6. Special Tail-center for the Bench Lathe, and Auxiliary Attachments

In the outfit of plugs to go with Fig. 2 there are two male centers cut partly away to different amounts, as shown in Fig. 5, a female center with a much smaller hole than in the regular female center, and a 60-degree countersink for centering shafts. Some of the plugs are special in their nature, as shown in Fig. 6, and are hardly worth keeping. These were made for turning shafts that were to run on pointed screws of a special angle, and as only one shaft of each kind was to be turned, the plugs were not even hardened, but were left soft and kept well lubricated when in use. The stock from which one of the screws was to be made was chucked and its point turned to the specified angle, as in Fig. 3. A small dog was then clamped on the part shown

dotted. This made a live center on which to turn the shaft, one of the plugs shown in Fig. 6 being used as a dead center. After the shaft was completed, the pointed screw was turned down for the shank, threaded and cut off, thus performing a double duty, as live center first, and as a finished screw for the completed machine afterwards.

Having to make a tap 0.040 inch diameter and 100 threads per inch, a piece of 3/16-inch brass rod was drilled lengthwise about ½ inch deep with a 0.040 drill, after which the outer end of the rod was cut partly away, as shown in Fig. 7, leaving about two-thirds of the original diameter of the hole in the brass. When this was clamped in the tail-center, Fig. 2, it made a very good steady rest, or back rest, for the slender wire to run in while doing the threading. The threaded part of the tap was only ⅜ inch long. Of course, a hardened steel plug would have answered much better, but the job was in a hurry, and the brass plug was more quickly made, and was plenty good enough.

The part shown dotted in Fig. 2, is cut away to clear the turning tool when finishing the end of a tube or a solid shaft with a straight hole in the end. The central hole in Fig. 2 goes all the way through, but it does not need to. It was made that way because it was easier to get all the parts true, the hole being made first. Since making this fixture, it has occurred to me that it would have been an excellent device to use on a lathe that I worked on many years ago, which was somewhat out of alignment. In that case the central hole would be bored in place after the taper shank was fitted to the tail spindle, taking the precaution, of course, to mark the fixture and the tail spindle, so that the fixture would always be placed, when in use, with the same side up as when it was bored.

* * *

MACHINE SHOP PRACTICE*

LAYING OUT WORK—2

Before laying out a machine part it is first well to consider its particular requirements in order to obtain a definite idea of the relation that the various surfaces must bear to one another when the part is finished and assembled; and, as the method of procedure is governed somewhat by the way in which the part will subsequently be machined, it is also advisable to first determine the most practicable method of machining, before beginning to lay out the work. As an illustration of the kind of work which the machinist is often called upon to line out, we have selected the engine cross-

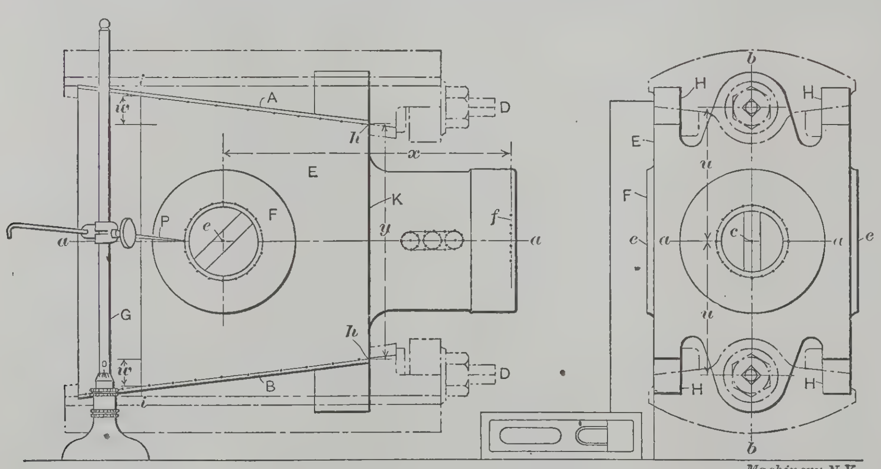


Fig. 1. Laying Out a Cross-head

head shown in Fig. 1, which is a type widely used. The shaded portion represents the main casting, and the dot-and-dash lines the shoes, or gibs as they are sometimes called, which are adjusted along the inclined surfaces *A* and *B* when there is too much play between the guides and the cross-head. In this particular case the principal requirements are that the axes of the piston-rod hole and the wrist-pin hole be at right angles; that the axis of the wrist-pin hole also be at right angles with the vertical center line *b-b*; that the inclined surfaces *A* and *B* have the same inclination to the center line *a-a* and be equi-distant from it; and that the guiding surfaces *H* be parallel with the axis of the piston-rod hole. Keeping these requirements in mind, we shall proceed to locate lines on the casting indicating the finished surfaces. After inserting centering pieces in the cored wrist-pin hole on each side and in the piston-rod hole as shown, locate the points *c* and *e* central with the outside of the bosses. A coat of whiting and alcohol, or chalk, should next be applied to those surfaces upon which lines are to be drawn. The casting is now ready to be set in an upright position on the surface plate, as shown in the illustration. The blocks which would be required to support it in such a position have not been shown, in order to avoid a confusion of lines.

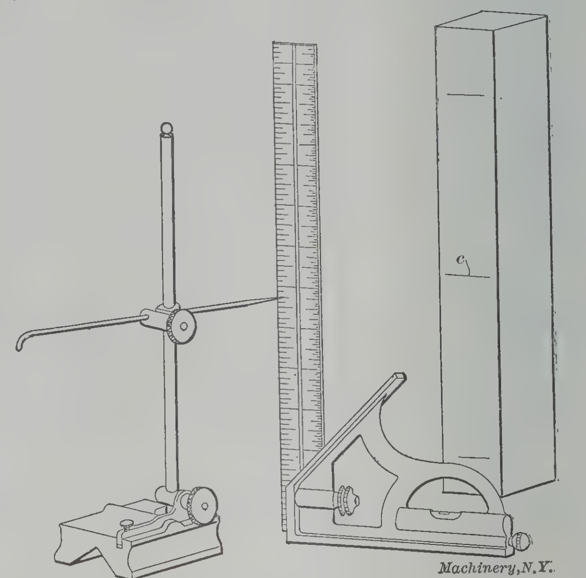


Fig. 2. Setting the Surface Gage to the Dimension u, Fig. 1, by the Combination Square

The rough sides of the casting are set at right angles to the surface plate by the use of a square, as shown in the end view. The center *c* and the two centers *e* (see end view) are now set in the same horizontal plane by the use of the surface gage *G*. This is done by inserting the pointer *P* of the gage in one of the centers and then moving the gage to the other centers to see if they coincide with the first. It may be necessary in order to set these three centers in the same horizontal plane to move the two centers *e* toward each other slightly. It is better that each center be moved in order that the finished hole will be as nearly concentric with the outside of the bosses as possible. When the casting is thus set, the surface gage is used to draw the center line *a-a* on each side and across the end of the cross-head. This is done by holding the scriber against the casting while the base of the gage is moved along the surface of the plate; obviously a line drawn in this way will be parallel with this surface. Ascertain from the drawing in which direction the wrist-pin is to enter the cross-head in order to find out from which side the hole for this pin will be bored, and then, with point *e* as a center, scribe a circle equal in diameter to the small end of the wrist-pin hole. This circle will be used to set the casting by when boring the hole in the lathe or boring mill. Another circle, the diameter of the small end of the piston rod hole, should be scribed with point *c* as a center. With a pair of trammels, a line *f* should be located a distance *x*, as given on the drawing, from the center *e*. We shall assume that the dimension *y* is given, and that the taper of the inclined surfaces *A* and *B* is in inches per foot. Then, to lay out lines for these tapering surfaces, locate points *h* and *h* equi-distant from the center line *a-a* and a distance *y* apart. With a square draw a line *i-i* 12 inches from the face *K*. With the surface gage transfer the points *h* to the line *i-i*, as shown, and then locate centers above and below these points a distance *w* equal to the taper per foot. Lines which are then drawn through these centers and the points *h* will have the

* With Shop Operation Sheet Supplement.

taper required. If the casting is not large enough to permit line *i-i* being drawn 12 inches from the face *K*, of course the same result would be obtained if this distance were a fractional part of a foot, providing the distance *w* were laid off to the same fractional part of the taper per foot. When locating the centers of the bolts *D* distances *u* above and below the center line *a-a*, the pointer of the surface gage should first be set to coincide with center *c*. The pointer may then be placed against scale of a combination square, and the scale moved vertically until the pointer coincides with one of the divisions, as shown in Fig. 2. If the dimension *u* then be added to the inches and parts of an inch indicated on the scale opposite the pointer, the sum thus obtained will be the division on the scale to which the pointer should be set when scribing the horizontal center lines for the bolts *D*. For example, if the gage pointer showed that the center line *a-a* was the same height as the 5¾-inch division on the scale, and if the dimension *y* on the drawing was 5¼ inches, the gage pointer would, when scribing the center line for the upper bolt, be set to 5¾ + 5¼ = 11 inches. The center for the lower bolt would, of course, be obtained by subtracting 5¼ from 5¾. In this way the scale of the combination square can often be used for accurately setting the gage pointer to vertical distances between points not in the same plane. A parallel block placed in a vertical position may also be used for this purpose. A center line *c*, coincident with the center in the work, would first be scribed and then arcs central with this line and the required distance apart would be struck with a pair of dividers or trammels.

One method of machining this cross-head would be to first bore and ream the wrist-pin hole concentric with the circle drawn for it, and at right angles with the rough surface *E*; the boss for this pin should also be faced. This finished boss can then be clamped against an angle plate (preferably on a vertical boring mill) when setting the casting for boring the piston rod hole. In this way the axes of the holes for the piston rod and wrist-pin will be at right angles, and if the center line *a-a* on the casting is set square with the table or face-plate, the axis of the two holes will also be in the same plane. By bolting the finished face *F* against an angle plate on the planer, the planes in which the finished surfaces *A* and *B* lie, will also be parallel to the wrist-pin axis, and the finished sides *H* for the shoe fittings will be parallel to the axis of the hole for the piston rod.

* * *

IMPROVEMENT VS. HUMANITY

An American and German were traveling by rail in Germany through one of the forests for which the country is noted. The wooded expanse on either hand showed the care of the trained forester. The trees were free from dead branches, and on the ground there was little or no debris. The roads were laid out with mathematical exactness; the sides were free from weeds and the gutters carefully graded and clear of obstructions. In short, the whole appearance of this great forest was that of a well-kept park, although miles and miles in extent. The German waxed enthusiastic and was constantly calling the attention of the American to the various features that attracted his admiration. He could not say enough for the beauty of the scene, for the well-kept appearance of the trees, the fine roads and the evidences of a mastery of nature and a carefully planned conservation of a valuable resource.

The American at last grew somewhat impatient and said: "You see one phase of this scene only, and that is the woods and the roads, while I am more concerned about another phase, which is the human side. Behold those men and women peasants broken down with toil before their time, stumbling along in wooden shoes, without hope, without courage and destitute of ambition! That is the other side of the scene not so fine. To me this scene is very depressing, for I see in it nothing for humanity. Of what good are all these roads, the well-kept forest, these water courses, when the men and women whose unremitting labor is required to do this work, have no joy in the prospect? Human happiness is worth more than all the improved roads and forests together, for without it all else is worthless."

GERMAN BENDING AND STRAIGHTENING MACHINE

A machine for bending cold iron and steel of round, square, T, I, channel and other sections is shown in Figs. 1 and 2. This machine which is built by Brüder Boye, Neue Friedrichstrasse 59, Berlin, Germany, is designed for bending and straightening small quantities of work of a special nature, which would not warrant the employment of special machines with expensive tools, such as bulldozers. The need of such a machine has long been felt by bridge and crane building establishments, shipyards, railway shops, machine

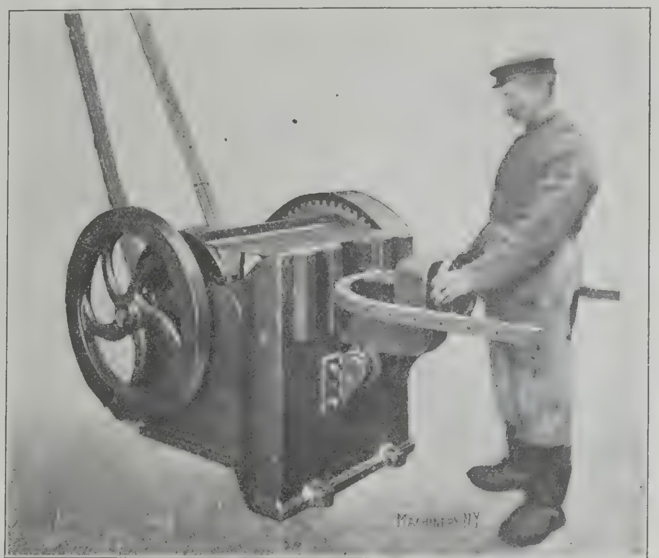


Fig. 1. The Power-driven Bending and Straightening Machine forming an Angle-iron

shops, etc. Although tools performing this work are in use, they are generally hand-operated and the results have been more or less unsatisfactory, both in regard to the output and the quality of the work produced.

As may be seen in the line engraving Fig. 2, the machine consists of a strong frame in the center of which is a massive steel ram *A*. This ram is connected at one end by an eccentric, which actuates it, and it is supported at the other by a roller *D*. In the end of the ram there is an adjustable spindle *C* which comes directly into contact with the work. By varying the position of this spindle, the piece being bent will

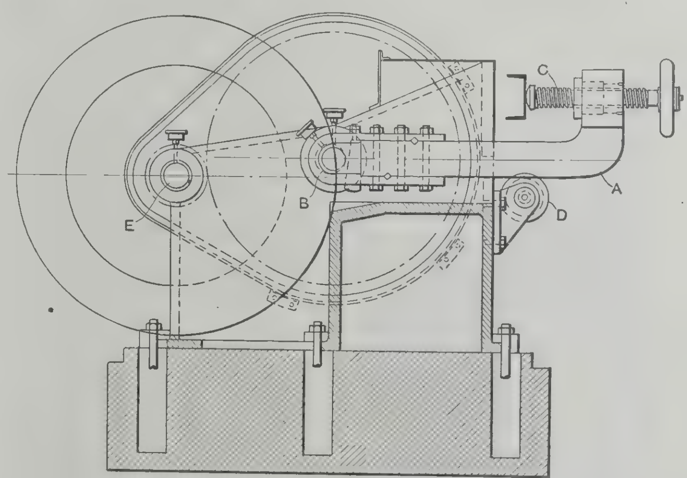


Fig. 2. Vertical Section through the Bending and Straightening Machine

be subjected to a greater or less pressure and the radius of the bend will be varied accordingly. The shaft upon which eccentric *B* is mounted is connected to the driving shaft *E* by reduction gearing. The speed of the driving shaft is 110 revolutions per minute, and the resulting speed of the ram is 25 strokes per minute. While the stroke of the ram, which is approximately 1 inch, is not changeable, the distance between its working end, that is the end of *C*, and the frame can be changed, as before stated, by simply moving *C* in or out by the hand-wheel shown, thus subjecting the work to a greater or less amount of pressure on each individual stroke. Obviously, this machine can be used either to bend

straight bars to any desired form or to straighten crooked bars. These bars may be round, square or any desired shape and the iron can be bent at any point by turning the work to the desired position. The various pieces in Fig. 3 show what uniform results can be obtained with this simple machine. Pieces having the same section throughout can easily and quickly be bent to approximately a true circle, providing the spindle C is not adjusted after a bend is started and the work is fed practically the same amount for each stroke. It is said that this machine bends the various

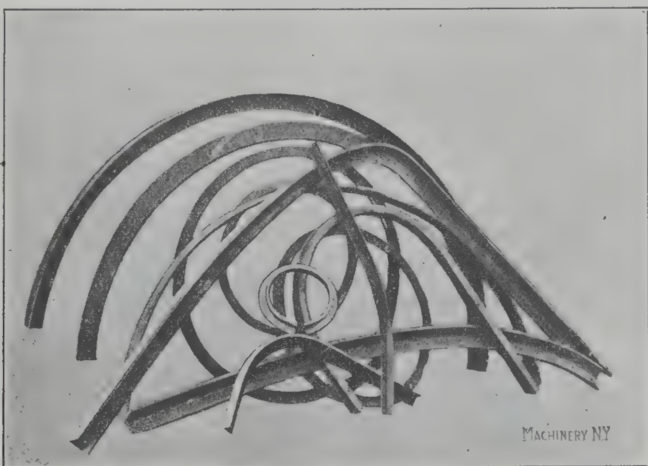


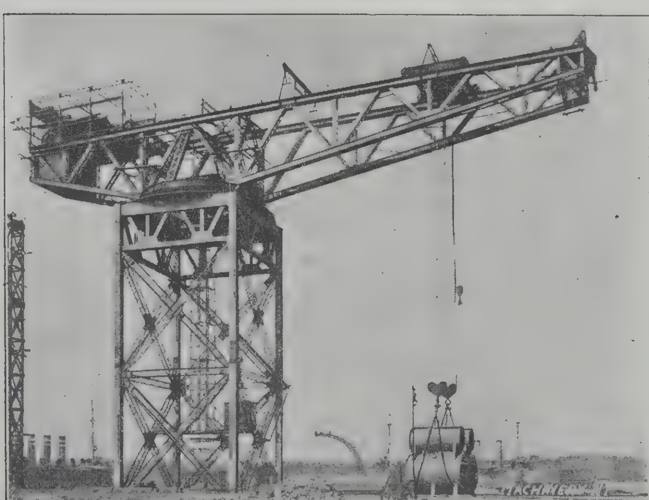
Fig. 3. Some of the Work done by the German Bending Machine

sections without any appreciable amount of buckling, which, considering the simplicity of its construction, is quite remarkable. When bending long pieces, the ends are supported by tables or horses which are arranged on both sides of the plunger or ram. Angle iron 2 by 2 inches in size can be bent to a minimum radius of 8 inches, while 4 by 4-inch angle iron can be formed to any radius greater than 2 feet 6 inches. The smallest radius to which an 8 by 3-inch channel can be bent is 4 feet 9 inches. The radius to which any material can be bent is, of course, dependent on its stiffness. About 3 horse-power is needed to drive this machine, and its weight, when ready for shipment, is approximately 2 tons.

* * *

THE LARGEST CRANE IN THE WORLD

The accompanying illustration shows what is stated to be the largest crane in the world and is the crane that was referred to in a short item in the August issue of MACHINERY,



Crane Capable of Lifting 240 Tons at a 95-foot Radius

engineering edition. As there stated, the crane will lift 160 tons at a 95-foot radius, and when tested it lifted a load of 240 tons. The illustration shows the crane while being tested ready to lift the load mentioned. The crane is erected at Devonport Dockyard in England. Its total height is 166 feet, its length over all 230 feet, and its weight 950 tons. It was built by Messrs. Cowans, Sheldon & Co., of Carlisle, and was designed by Mr. J. W. Branston.

THAT NEW APPRENTICE BOY

A. B. SAW

Terry, the new apprentice, came into the pattern-shop about three months ago, bringing his dinner wrapped up in his apron and towel and looking for all the world like a raw recruit from the Emerald Isle; but after he had been there three or four days, he was one of the most welcomed boys that ever got his trademarks in the shop.

He was, as one of the journeymen expressed it, "always keeping us in good spirits by doing funny stunts and asking innocent questions about his work."

The second day that he was in the shop, the boss came to him, where he was sorting screws, and said: "Terry, you can have that bench up there by the band saw for a while, it's kind of old but it will hold you for a time." "All right, sor," says he. So hurriedly finishing his work, he went up to the bench and started to tidy up a bit, feeling as big as life to think that he had a bench all his own.

When he had it fixed up nice and clean, he noticed with dismay that the top of his bench was full of small holes and knife cuts, while the tops of the adjoining benches were smooth and shiny. However, this down-cast mood soon gave way to one of delight because he had an "idea" that would remedy the unsightly appearance of his bench. "Why not fill up those holes with beeswax?"

For two hours he dug and worked at the old bench filling the holes with beeswax. This made the men jolly him a

"Begorra, I'll give it a good draft"

good deal, and they dubbed him "Beesy," a name he went by for the rest of his apprentice days.

Not long after this little incident, he was given a flange to make, twelve inches outside diameter, six inches inside diameter, and about two inches thick. He turned it up in the lathe and, as he thought, "made a pretty foine job." He took it up to the boss, who, after measuring it up, tried a small square to the edges. "There's no draft on it, Terry, give it a little draft and it will be all right."

Terry went back to his bench with a perplexed look on his face, until the meaning of the word "draft" dawned on him. "Begorra, I'll give it a good draft," said he, and at that he put the flange upon the window ledge and opened the window about three or four inches, letting the cool breezes from the water blow on his pattern.

About half an hour afterwards he came over to my bench and said, "Do youse think there's enough draft on me pattern, Mr. Saw? It's been there thirthy minutes."

Well, I explained to him, with a straight face, what the meaning of "draft" was, when applied to a pattern; but I must confess that after he had gone I had to give way to my suppressed mirth, and when the story was repeated to some of the others, they joined in with me.

* * *

The minute a man begins to consider himself indispensable he ceases to be.—*The Silent Partner.*

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

CASTING NEW FACES ON WORN VALVE SEATS

The accompanying view shows the operation of casting a new face on an old valve seat of a locomotive cylinder, as it is performed at the Firenze (Florence) repair shops of the Italian State Railways. The illustration shows the cylinder with the mold clamped to it ready for the pouring of the metal from the adjoining cupolas. Briefly described, the process consists of removing the worn or damaged part that is to be renewed, and fixing in its place the mold of the new part. Before running the metal, the cylinder is highly heated and then the pouring is performed in such manner that the metal runs freely over that surface of the cylinder which is to be fused and welded, and then passes out through a hole such as is shown in the side of the mold in the photograph. After running from 200 to 500 pounds of metal, the old metal softens and melts; the escape hole is then plugged and the mold filled up to the top of the runner head.

Unless a cylinder has been rebored so many times as to approach its final limits for thickness, this process is found to be cheaper than casting new cylinders and then machining

Casting a New Valve Face on an Old Cylinder—Italian State Railway Shops at Florence

them. The new gas "welding" processes would not be so economical in Italy considering the thickness to be melted for a weld joint; this too is the experience in French railway shops where autogenous welding (*soudure*) has been practiced for some time with considerable success up to a certain thickness, past which ordinary methods become cheaper.

C. R. K.

A VARIABLE LINEAL SPEED DRIVE

Fig. 1 shows a general view of a slide *A* which moves back and forth in a straight line with a variable speed by means of a common rack *B* securely mounted on the slide, and a spiral spur gear *C* keyed on the shaft *D* running at a constant speed. From the drawing it can easily be understood that this spiral gear can only make a part of a turn or possibly a little over a turn before reversal, in order to move the slide in the desired direction. The reversing of the shaft *D*, on which the spiral is fastened, is done by a jaw clutch body *E* sliding on a feather on shaft *F*, and engaging automatically with either one of the two pulleys *G* and *H*. These pulleys, located one on each side of the clutch body *E*, run continuously in opposite directions, thus changing the direction of the rotation of shaft *F*. On this shaft there is a worm fastened which meshes with a worm-wheel fastened to the spiral gear *C*. The rack is mounted on the slide at a certain angle depending upon the required variation in speed, which is in direct proportion to any line $m—m'$ or $n—n'$ drawn from the pitch line of the rack perpendicular to the center line $I—J$. It would not be advisable to mount the rack on the slide at a steeper angle than 30 degrees. If the angle be more than this a greater resistance to the movement of the slide will occur.

The diagram, Fig. 2, shows how to construct the spiral gear when the pitch and the angle to which the rack is set are given.

The center line of the spiral gear is located as near as possible to the lower end of the rack, just enough space being left to get a good size hub around shaft *D*. In this way the

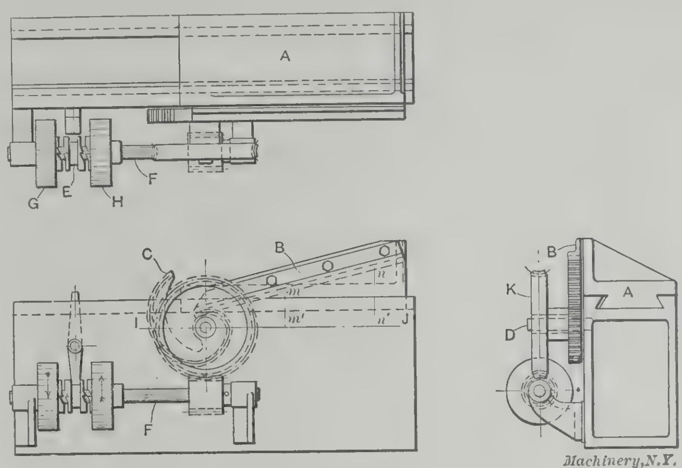


Fig. 1. Mechanism with a Spiral Spur Gear for Imparting a Variable Lineal Speed to a Slide

smallest possible spiral gear required for the movement will be obtained, providing that the movement of the slide is not too great, in which case the size of the spiral gear may have to be increased in order to get the right number of teeth. First, space off one-half of the pitch *a*, *b*, *c*, *d*, *e*, etc., on the proper length of rack and then project lines to the center line $I—J$ from each one of these divisions. With *A* as a center and aa', bb', cc', dd', ee', ff', gg' as radii, strike small arcs as shown at b'', c'', etc. Space off half of the pitch on these arcs, going from one to another to get the intersecting points for the pitch lines of the spiral gear. By rights the pitch should be measured on the spiral, but for a small pitch

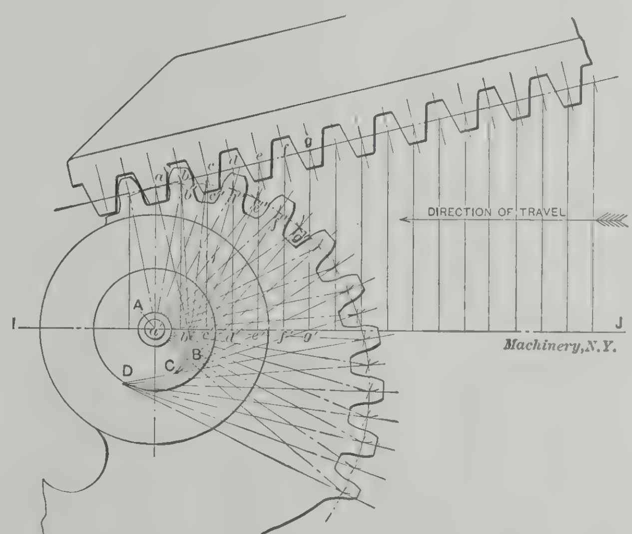


Fig. 2. Method of laying out the Spiral Spur Gear

the difference is so slight that it need not be taken into consideration. When all the intersecting points are found, find the centers *B*, *C*, and *D* needed for forming the spiral. Lines drawn from these centers through the intersecting points b'', c'', etc., will give the center lines for the teeth and spaces in the spiral gear.

For cutting the spiral gear, a templet was made having the correct shape of the teeth according to the various radii in the spiral. This templet was fastened on the blank and the spiral was cut in the regular way, only that it could not be cut with one cutter as the shape of the tooth changes with the spiral. [The paradoxical name of spiral spur gear given the gear illustrated in connection with this article

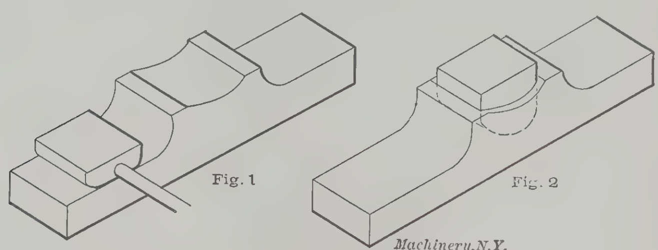
illustrates the folly of naming what is really a helical gear a spiral gear, as the gear here shown is truly spiral in form. —EDITOR.] EDWARD PERSON.

Brooklyn, N. Y.

FORGING DRIVING BOXES

Forged driving-boxes are preferred to steel castings by many European railway works. On account of their great height there are some difficulties in the way of forging them direct in the press. The accompanying sketches show how this work has been simplified at the Epernay shops of the French Eastern railways.

The billet for the driving-box forging is first rough-dressed as shown in Fig. 1, and then, with the aid of a die, the hollow is shaped in the crown as at Fig. 2. The third operation is to channel the sides as shown in Fig. 3, and then swage the middle portion on the block, or matrix, as in Fig. 4. The forging is then passed to the press in which it is given a truer form by a die and matrix. The sixth operation is to close up the sides or cheeks of the box by straightening out the curved ends according to the manner shown in Fig. 5, and the seventh and final operation is to square up the forging on the form or die as in Fig. 6.

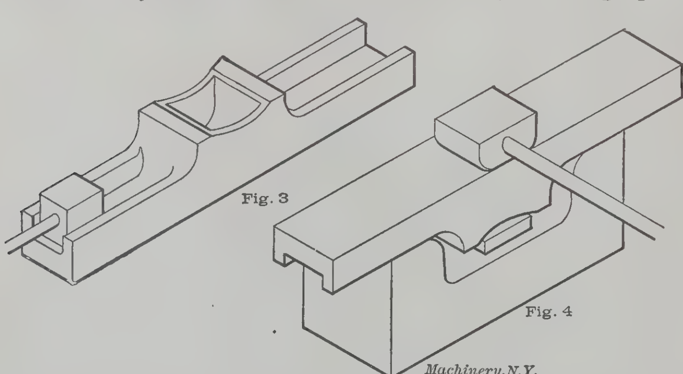


Figs. 1 and 2. Rough Dressing and Shaping the Crown of the Box

The weight of the billet being 264 pounds, the forging thus far completed will weigh 172 pounds, and, after machining, the finished driving box will weigh 105 pounds. For heavier finished boxes the weight of the billet and forging are correspondingly heavier. C. R. K.

BLIND ACCEPTANCE OF AUTHORITIES

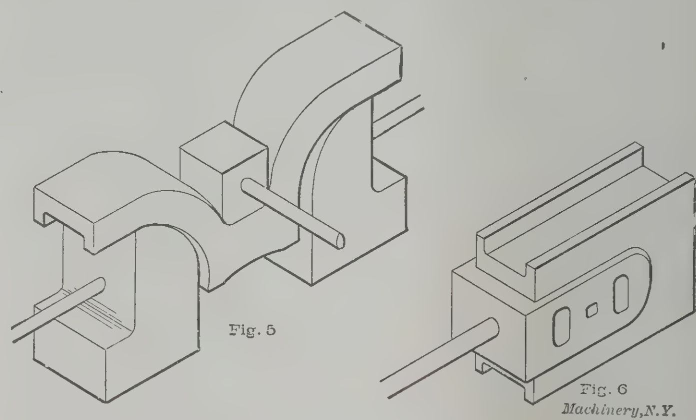
In the June number of MACHINERY, in an editorial, some space is devoted to what is perhaps the greatest fault of the young college-bred engineer—that of adhering blindly to rules laid down by the authorities. No text-book, or college professor, however, can overcome the handicap of a poor memory or lack of good common sense; neither should such authorities be credited with mistakes resulting from such inability, nor should ridicule emanating from it reflect on them.



Figs. 3 and 4. Channeling the Sides and Swaging the Middle

Incidents concerning the deeds of college engineers are plentiful, and two old, familiar ones may bear repeating. One young man while employed in a drafting-room was given the task of making the necessary drawings for a certain mechanism. When completed he turned the "drawing" over to the chief along with twelve closely written sheets which he said were directions for the drawing. The other engineer in writing of a new locomotive stated that it weighed 160,000 pounds, though the actual weight was slightly in excess of this, for the boiler carried 200 pounds of steam!

Just how some students manage to graduate is hard to conceive. Quite recently a graduate of the engineering school of a large university was unable to tell what part of a dynamo was the commutator. It is impossible to believe that any part of a college training is responsible for such glaring ignorance and errors. Happily for him, the college engineer may sometimes link arms with the practical man and share the "knocking" that his co-workers are only too ready to administer. Witness the following: The mechanical superintendent of a certain factory, a man of 35 years experience in various positions from apprentice to machine shop owner, was telling with a show of pride how he had forestalled a move to put 12 presses on the fourth floor of one of their buildings. The machines were hydraulic presses weighing 1,500 pounds and capable of exerting 35 tons on any article placed between the platen and bed. "Why," said he, "those floor beams are only 2×12, set 2 inches into the brick, and with all 12 presses working there would be 400 tons on that floor; I'd resign my position before risking lives that way."



Figs. 5 and 6. Closing in the Sides and Squaring the Forging

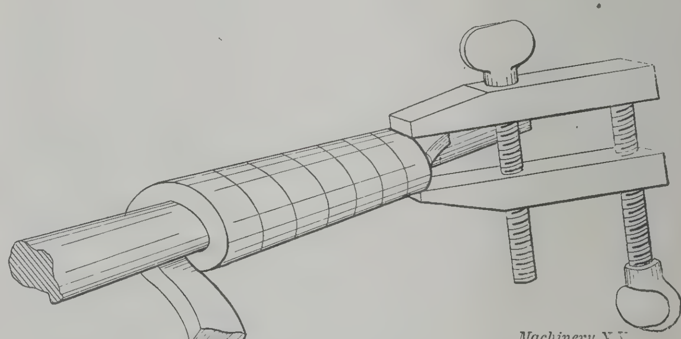
Let us have all the training obtainable; that, tempered with good common sense and coupled with broad, practical experience will give us the engineer par excellence.

Middletown, N. Y. DONALD A. HAMPSON.

A CHEAP BUILT-UP LAP

A great deal of machine work would be considerably improved by having the holes which require accuracy, lapped smooth and true, but the equipment of the average machine shop does not include laps of all sizes, and if a few are carried the chances are all in favor of their being of the wrong size for the work in hand.

It does not take very long to make a lead lap of the ordinary kind, but molds must be provided for casting them, and, as the variety of work to be lapped is infinite, it is practically impossible to have a complete set of molds. Casting laps upon a tapered arbor, as is customary, also requires that the holes in the mold must fit the arbor to be used, at the place where the lap is desired on the arbor, and as that place may vary or one may wish two separate laps on one arbor for lapping journals some distance apart, variations of hole size must be compensated for by the use of clay or some similar expedient. Another fault of the cast lead lap is its tendency to run dry and bind in the hole, unless carefully scored to provide oil channels over most of its surface. It also must be split if of any considerable size as compared to the arbor, or it will require too much of a blow on the arbor to expand it, if this be possible at all.



Forming a Lap by winding Narrow Strips of Sheet Lead around a Taper Arbor

To reduce the work required to make a lap, and provide material which can always be worked up into a lap on short notice without casting and without the use of molds, keep a piece of sheet lead about 3/16 or 1/4 inch thick, or even thicker, on hand. Use the same taper arbor as for the cast lap, and place it between the centers in the lathe. Cut a strip from the sheet lead about ½ inch wide with the tin shears and fasten it to the arbor a little nearer to the small end than you wish the end of the lap to be, with a clamp or lathe dog, as shown in the illustration. Now wind the lead strip as tightly as possible upon the arbor in the same way that a helical spring would be wound, tapping the lead with a hammer to produce an impression of the spline, if a splined arbor is used. If one layer of the lead does not give a lap large enough to turn to the desired size, another layer can be wound over the first in the same direction, but beginning at the opposite end. This operation may be repeated until the desired diameter is obtained, after which it is often well to fuse the ends together with a soldering iron if the lap is very large. The whole can now be driven firmly onto the arbor and turned true and round in the lathe. The helical grooves left between the various convolutions of the strip serve admirably as channels for the proper distribution of the oil and emery, and this construction will be found more elastic and easily expanded than the conventional cast lap.

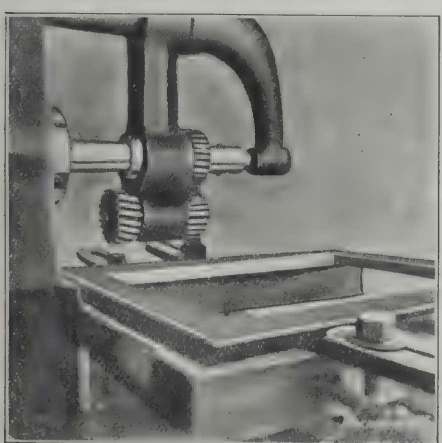
Needless to say, the lap must be run so that friction with the piece to be lapped will tend to wind the lead strip more tightly around the arbor; this proves quite an advantage rather than a disadvantage as it makes it possible to use an unsplined arbor without the constant danger of the lap slipping on it. On laps having but a single layer of lead it will be found desirable to reduce the diameter for an inch or so at the small end to prevent friction with the piece to be lapped, which would tend to unwind it. On laps of two or more layers this will not be necessary. HERBERT L. THOMPSON.

Elgin, Ill.

CORNERING TOOL FOR THE MILLING MACHINE

During periods of industrial depression a struggle for existing business is very naturally induced, which results in prices trimmed so close that there is little or no profit in handling the work. Business of this class, however, serves to keep together for future increase a force of men trained in some particular line of work, and for such purpose is self-justifying.

In an ambitious attempt to transfer some of this competition type of work into profitable business the "square cornering" tool, shown in the engraving, was evolved. We had a large number of flat castings ¾ inch thick, with a rectangular opening 12 x 15 inches, the sides of which had to be machined straight and square with each other. As the speed of the cutters limited the time consumed in milling the sides, any reduction in manufacturing cost had to be made by cutting the time between, or rather after, these cuts had been taken. Therefore it was desirable to remove the sections left in the corners by the straddle mills as quickly as possible. The device by which this was done was simply an auxiliary arbor suspended below the regular arbor and driven by spur gearing. The castings were clamped on parallels, as in slotter work, and passed across the cutter by the elevating screw. This was a lighter task than would at first appear, for the weight of the knee formed a hold-back that permitted the work to be fed *into* the cutter, which, in turn, materially assisted in lifting the weight by its upward movement. This device turned out ten complete castings, or forty corners, in one hour, using a carbon steel cutter. DONALD A. HAMPSON.

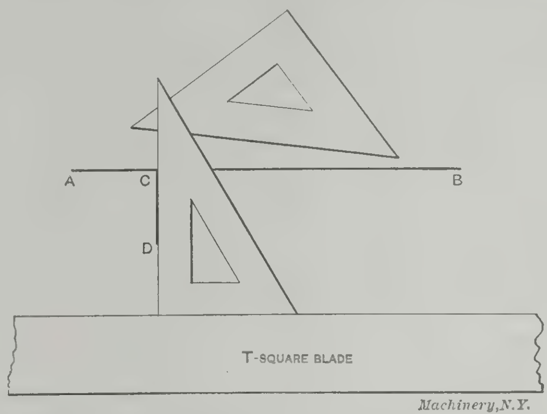


Cornering Tool attached to the Milling Machine and Example of its Work

Middletown, N. Y.

TO AVOID BLOTTING FRESH INK LINES

It sometimes becomes necessary for the draftsman to draw short vertical lines before the horizontal ink lines are dry, and it is impossible to lay the triangle on them without causing a blot. The lines can often be drawn by laying one triangle over the other, to lift it off the paper, as shown in the sketch, where the line *A—B* is supposed to be a freshly inked line, and it is desired to draw the line *C—D* without waiting for *A—B* to dry. One triangle can be laid on the board just above *A—B* with one edge approximately parallel to it. Then the upper end of another triangle can be laid over the first, its lower edge being guided by the T-square blade in the usual way. This lifts it clear of the line *A—B*, and *C—D* can be drawn just about as well as though the triangle were flat on the paper. WALTER GRIBBEN.

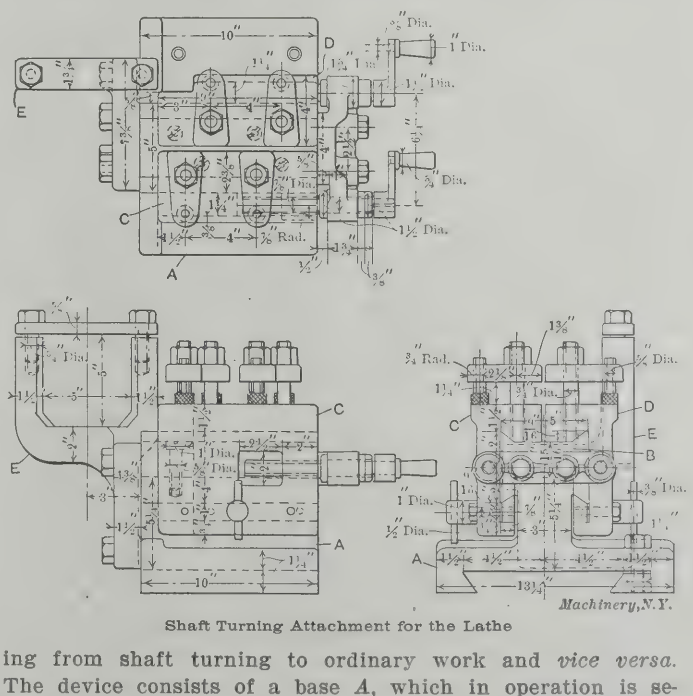


Method of using Triangles to avoid Blotting Fresh Ink Lines

Brooklyn, N. Y.

A SHAFT TURNING ATTACHMENT

We recently had to supply a three-tool rest for shaft turning which had to fit onto a lathe which was used for practically any job that came along, and as shafting seemed to come along pretty often, it was thought advisable to provide some means whereby this kind of work could be more economically dealt with. It was desired that the attachment be so designed that little time would be required in changing from shaft turning to ordinary work and *vice versa*. The device consists of a base *A*, which in operation is securely clamped to the cross-slide of the lathe; a slide *B* on which tool-holders *C* and *D* work, and a stay *E* which carries either metal or hard wood steadies for supporting the work. The slide *B* is made separate from the main casting



Shaft Turning Attachment for the Lathe

A so that the bearing surfaces may be more easily machined and scraped to fit. It will be seen that the tools come quite close together and yet plenty of room is left for the handles which work the screws for adjusting each tool.

In operation the ordinary tool rest of the lathe is moved to the back of the carriage and the two-tool rest mounted on the front. The back rest carries the roughing tool which is, of course, clamped with the cutting edge downward. The left-hand tool-holder of the attachment carries the first finishing tool, while the right-hand one carries the finishing tool proper. All three tools are under perfect control from the operator's working position in front of the lathe (the back tool is, of course, adjusted by the regular cross feed screw) and when the lathe is needed for work other than shaft turning, five minutes, at the most, is all that is required to dismount the shafting attachment.

I might say, in conclusion, that with this arrangement a feed of 1/32 inch per revolution of spindle leaves a fairly good finish which only needs polishing to meet ordinary requirements. A good stream of lubricant is required on the tools, particularly if high speed tools are used. RACQUET.

SWINGING INK-BOTTLE HOLDER FOR DRAWING TABLE

Experienced draftsmen know the risk in keeping the ink bottle on the drawing board, especially if it be a sloping board. Even when the bottle is fastened in a heavy base to avoid tipping over, it may slide off the board, or ink may be dropped on the surrounding board or paper when filling the pen, and anyway it is in the way and takes up space on the board. To avoid these difficulties, I designed and had applied to several drawing-tables the device shown in Fig. 1, which has been found very satisfactory and convenient. The line illustrations, Figs. 2 and 3, show the construction with certain improvements over the original design shown in the half-tone.

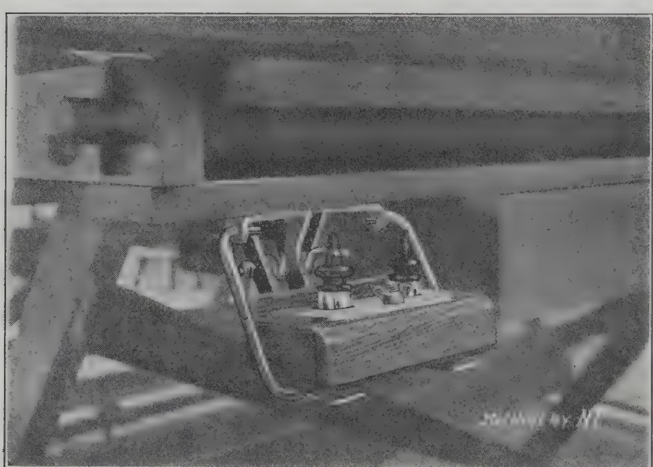


Fig. 1. Holder for Two Ink Bottles, which is easily swung out of the Way

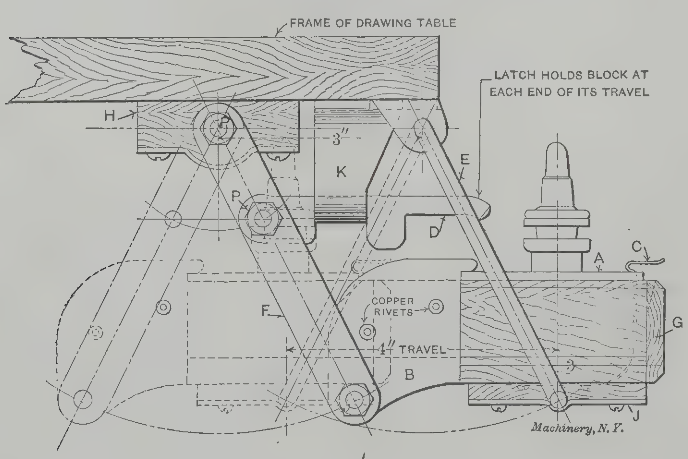


Fig. 2. Side Elevation of the Holder, showing the Inner and Outer Positions

The device illustrated may seem to have a great many parts, as compared, for instance, with a drawer, which is the first thing one would think of for the purpose; but a drawer on this folding drawing table would have been in the way, and a slide of ample length would have required more depth than was here available. This holder is located next to the left side of the draftsman, and in the half-tone it is shown pulled out, affording ready access to either of the two ink bottles which are locked fast in it, and requiring one hand only for removing the filling quill. The bottles may be quickly removed for changing or renewing, by unscrewing the one thumb-nut and removing the brass retaining-plate *A* (Fig. 2), the back edge of which slips into the recess in the wooden strip at the back. In the improved design this wooden strip is done away with, as is evident in the line drawing, ears being formed on the plates *B*, instead; also the thumb-nut and screw have been superseded by a spring clip, *C*, making it still easier to remove the bottles.

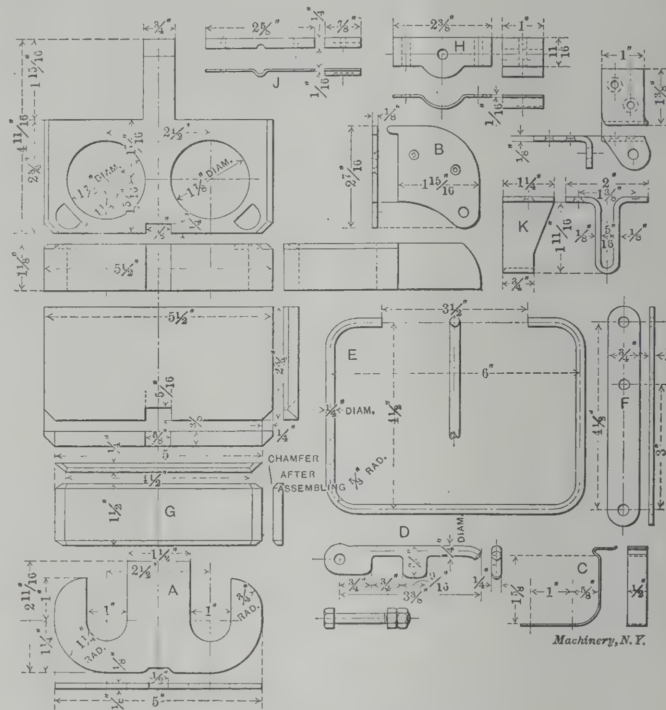


Fig. 3. Details of the Swinging Holder

After inking the pen, lifting the latch *D* with the tip of the finger enables the holder to be instantly pushed back out of the way; at the back end of the stroke the latch drops into place again and the swinging holder is retained there, entirely underneath the table and out of the way. The construction should be clear from the drawings, the marks or symbols used being the same in Figs. 2 and 3. The wooden parts of the holder are glued together, other fastening being afforded by the wood screws and the rivets indicated in the assembly drawing, Fig. 2. The portion of the drawing table to which the holder was attached is permanently horizontal, the drawing board, of variable slope, being pivoted above. Attachment was made by 8 wood screws; of course, if desired it could be all attached to a separate block, permitting, in the event of shipment, removal without disassembling.

Berkeley, Cal. H. J. KENNEDY.

HOSE COUPLING AND CLAMP

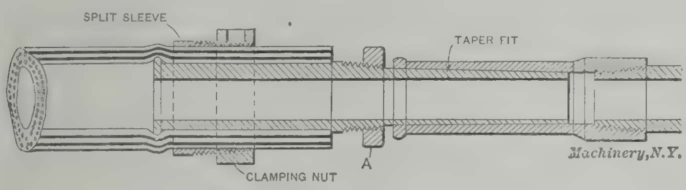
There are a great many different styles of hose couplings on the market, but still there seems to be room for improvement. No matter how careful the operators of pneumatic tools are, there is always a certain amount of time lost because couplings slip out of their hose or because the quick-adjusting types become disconnected. This trouble may be caused by poor construction and partly by rough handling.

The accompanying engraving shows a quick-adjusting hose coupling and also a hose clamp, that are giving satisfaction.

This coupling has a taper of 1/32 of an inch in 3 inches, which is very gradual, and when the parts are connected with a quick jar the taper "bites" so that they seldom come apart. When the coupling is to be disconnected, the parts are twisted by placing a wrench on the nut *A* provided for

that purpose. This takes time, but it is well spent as most couplings that can be taken apart by hand are generally leaky or very liable to come apart with the pressure on, and possibly cause an accident.

The hose clamp shown, is made of brass tubing. It has a 16-pitch taper thread cut on it and is split with a hacksaw in about six places. A knurled nut is also provided which is drilled for a round spanner, for tightening. As the nut is screwed on the taper thread, the tube takes a firm grip on the hose, which, in turn, is compressed against the inside connection or coupling.



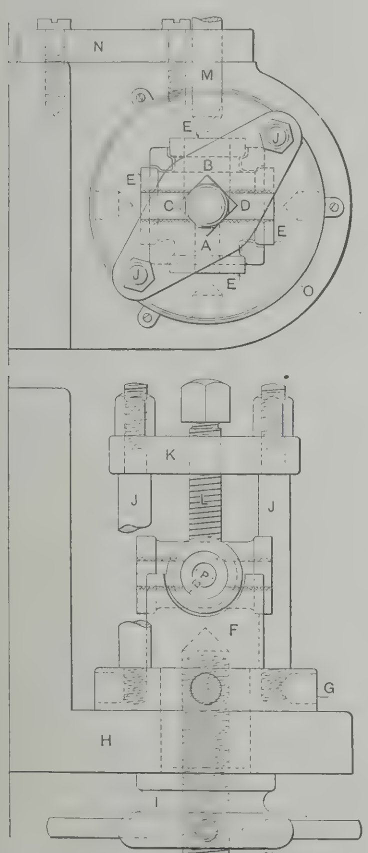
Simple Form of Hose Coupling for the Air Hose

This clamp has no extending parts such as screws, bolts or lugs which are usually found in hose clamps, to catch, as the operator pulls or drags the hose along the floor or ground. The hose couplings on one end are either made to screw on a nipple or be clamped in a hose. It will be found quite profitable in a large works to have patterns made and then cast the parts of brass as the occasion demands, rather than to buy and experiment with couplings of various kinds.

R. S. F.

TURRET LATHE FIXTURE WITH INDEXING ATTACHMENT

In the accompanying engraving is shown a fixture for facing, drilling and tapping the knuckle in a universal joint. This fixture, when in use, is mounted on the face-plate of a turret lathe, and with it the several operations are done very rapidly and at one setting of the work. These knuckles must be interchangeable, as they are used for repairs. They are made of malleable iron, and it is necessary to face the four sides *E*, drill holes 3/8 and 9/16 inch in diameter at *A* and *B*, respectively, and drill and tap the holes *C* and *D*. The castings are located in the fixture in the correct position by the holder *F*, the top surface of which is made to conform to the four flanges, there being clearance for the body of the casting. The holder *F* is made a press fit in the steel ring *G*, and the protruding end is made a sliding fit in the angle-iron *H*. Tapped into *F* is a stud on which the clamping-wheel *I* is mounted. Two tie-rods *J* are screwed into the plate *G*, and at the ends of these rods there is a strap *K* through which passes the clamping screw *L*. In the ring *G* four holes are drilled to receive the index pin *M* which is mounted in the arm *N*. This pin is held in place by a spring not shown. In the illustration the fixture is shown with the work in place, machined and ready to be taken out, which is done by simply releasing the clamping screw *L*. The changes are made for the different holes by releasing the clamp-nut *I* and withdrawing the index pin, after which the work can be turned to the desired position, the index pin locating the chuck while it is being clamped by the nut *I*. To prevent any dirt or chips from working into the index holes, a band of brass *O*, having a hole for the index pin, is placed around the ring *G* and fastened to the angle-iron. This fixture can be used for more than one class of work, as the holder *F* can be removed and replaced with one of a different shape and size.



Fixture for Universal Joint Knuckles

C. A.

OBTAINING DIAMETERS WITH A BEVEL AND SCALE

That diameters may be obtained by the use of an ordinary bevel and scale, is perhaps not as well known as the advantage of this method merits. Of course, these tools are only used when it is impossible to caliper the piece, as would be the case were it necessary to determine the radius of the cylindrical surface shown in Fig. 1. In order to obtain a diameter with the above tools, the bevel must be set to a certain angle previously determined, which corresponds to the graduations on the scale; then the diameter can be read directly from the scale. For example, if the bevel is set to an included angle of 125½ degrees, as illustrated in Fig. 2, and the distance x from the surface to the apex of the angle is measured with a scale, as shown in Fig. 1, the diameter may be readily determined, for it will contain as many inches as there are sixteenths of an inch in the distance x. Thus, if x equals ¼ inch, which is equivalent to four sixteenths, the diameter would equal 4 inches. When the bevel is set to 140½ degrees, each 1/32 inch represents an inch of diameter; 142¾ degrees, each 1/10 inch; 106¼ degrees, each ⅛ inch; 83⅝ degrees, each ¼ inch; 60 degrees, each ½ inch.

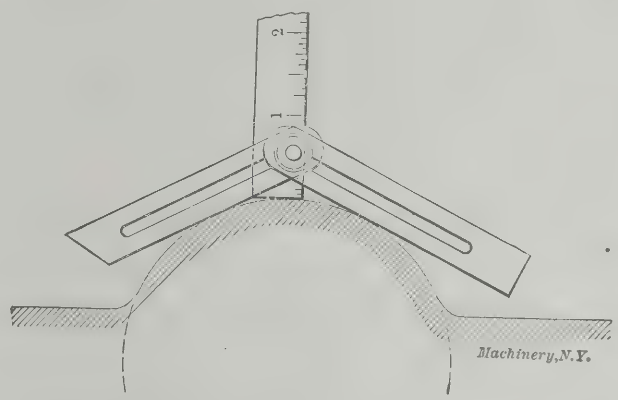


Fig. 1. Method of applying Bevel and Scale to Work which cannot be Calipered

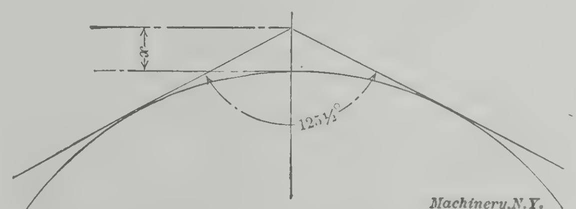


Fig. 2. When the Bevel is set to the Angle shown, each 1-16 inch in the Dimension x is equivalent to 1 inch of Diameter

It will be noticed that the less the angle the greater the distance representing inches becomes, and consequently the smaller the range of diameters which can be obtained. Thus, if the angle is set at 60 degrees, each half inch on the scale will represent an inch of diameter, and accurate fractional diameters can be obtained; but with this angle a large diameter could not be measured, and it would be necessary to use the bevel set at a greater angle.

A carpenter's square can also be used to obtain the same results, but a little calculation is necessary to get the diameter. After measuring the distance x with a scale, as explained, it must be multiplied by 4.83 in each case where an included angle of 90 degrees is used. Thus, if the distance measured 4 13/16 inches, the decimal equivalent to 13/16 should first be found, and the number 4.812 multiplied by the constant 4.83. The result would be 23.242 inches, which represents the diameter. As before stated, this method is

intended to be applied to inaccessible diameters, but it can often be used to advantage for measuring pulleys, etc., which are too large to permit the use of calipers.

C. E. J.

LARGE COMPACT DRAWING-BOARD

At the present time many shops are figuring on propositions which require large layouts, and the ordinary drawing-boards are far too small; yet conditions do not warrant the purchase of a large outfit or perhaps there is no room available, and to meet the conditions requiring large capacity and minimum floor space, the board here shown has been built.

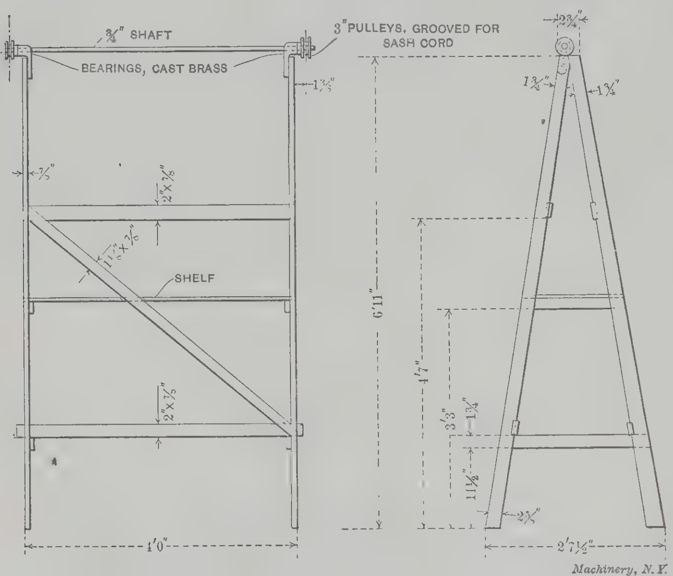


Fig. 1. Elevations of the Drawing-board Frame or Easel

It proved so useful that a second one was asked for and both are now in constant use. The frame, or easel, as artists would term it, is shown in Fig. 1. Only general dimensions are given, for such details as placing screws and making joints can be decided by the workman. The shaft, pulleys, and bearings, shown at the top, carry the counterweights needed to balance the drawing-board. Fig. 2 shows the general dimensions of the board and straight-edge. The board is built of ⅞-inch stock in the usual manner, with a brace at each end and one in the middle. The end braces also act as guides, their centers coming in line with the center line of the pulleys on the shaft shown in Fig. 1. A 25-pound window-weight at each end serves as a counter-balance for the board which is thus easily raised or lowered.

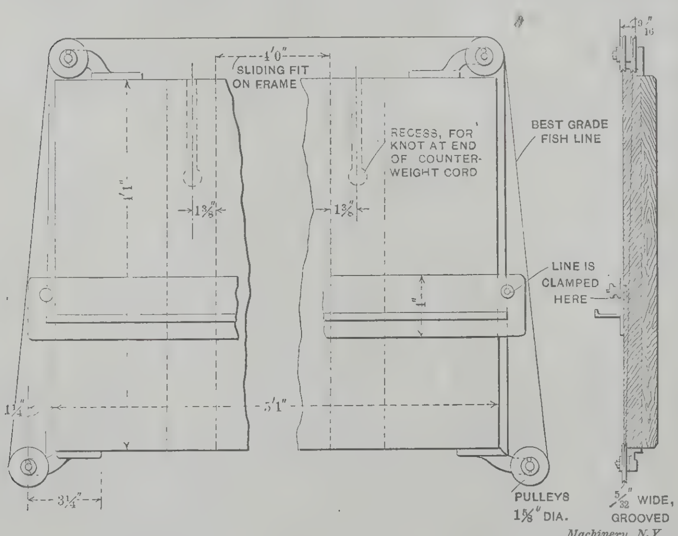


Fig. 2. Detail of the Drawing-board and Straight-edge

The straight-edge requires care in making, as both the upper and lower edges should be parallel. The projecting shelf is intended primarily as a brace but it is also very handy for holding tools. By means of the line and small pulleys, shown in Figs. 2 and 3, the straight-edge is moved and kept in a parallel position at every point, the line being clamped at each end of the straight-edge by a brass screw and nut. The straight-edge is counterbalanced by a weight of cold-rolled steel hung from a cord attached just above the brass clamping nut.

The material used was as follows: 25 feet of pine, 15 feet of white wood, 2 pounds of brass used in the small pulleys and bearings, 53 pounds of cast iron in the drawing-board counter-weights and large pulleys, 4 pounds of cold-rolled steel 1 inch in diameter for the straight-edge counter-weights, 7 pounds of cold-rolled steel ¾ inch in diameter for the shaft at the top of the frame, 25 feet of window cord, 35 feet of best quality fish line, and 3 dozen wood screws.

The time required to build this board depends, of course, on the skill of the workman. About 25 hours seems to be a good average time, a large part of which is spent in gluing the board. Foreign engineers say that this type of board is very generally used in Europe, and while at first sight a designer will usually disapprove of a vertical board, a few hours trial will prove its merits.

RALPH W. DAVIS.

Rochester, N. Y.

TOOL-ROOM CHECK SYSTEMS

I have read with considerable interest the articles dealing with checking systems for tool-rooms which appeared in the numbers of March, May and July. The various systems which were mentioned each has its merits and its defects as will any system, for keeping account of tools or supplies of any kind, which depends upon human care and intelligence for its operation. The efficiency of the system will also vary directly with the quality of the care and intelligence employed.

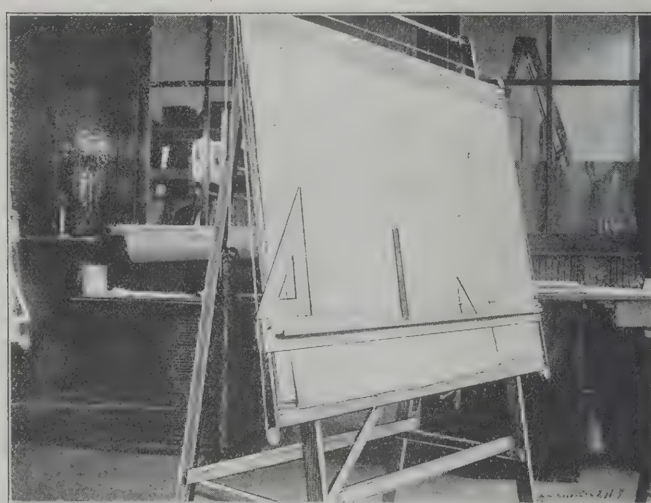


Fig. 3. Compact Drawing Board having Independent Vertical Adjustments for Board and Straight-edge

It is not my intention to put forth a better method of checking tools taken from the tool-rooms, but merely to call attention to another method which has recently come to my notice and is in operation and giving satisfaction in a large railroad shop in the East. This system consists of giving the checks to the tools instead of to the men, and it is operated as follows: A board large enough to accommodate the names of all the men who are to be served with tools, is placed in the tool-room in a location convenient to the man in charge of the distribution of the tools. Opposite each name is a hook upon which the checks are hung. The tools are numbered and the checks are also numbered to correspond. When, for example, John Jones calls for a 1-inch reamer which is number 27, the reamer is taken from its case and the check number 27, which is on a hook at the side of the case, is hung on the hook opposite John Jones' name on the board. Upon the return of the reamer the operation is reversed. The shop in which this system is in use, adopted it to overcome the trouble that was being experienced by the men losing checks and to put the prosperous check-borrow sharks out of business.

I am of the opinion that the system could be improved by supplying each man with a certain number of checks, keeping them upon a hook opposite his name on the board and exchanging one of these checks with the tool check when a tool

was taken out. This would be practically a debit and credit system of checking. Another road which uses the system of giving the checks to the men, provides for their loss by placing a value of 25 cents upon each check and deducting this amount from the man's wages for each check that is lost.

Chicago, Ill. G. E. RYDER.

The following system for keeping a record of the tools which the workmen use and which are regularly kept in the tool-room, will be found to give entire satisfaction, both to the workmen and management. It consists of two boards, each with a number of hooks equal to the number of workmen to be served. The hooks are numbered in consecutive order. On one board which is the *in* board, a number of tool checks are hung on each hook; in this case ten. The other board is the *out* board. The system operates as follows:

Every workman, when employed, receives an identification number corresponding to his number on the time recorder. Every tool kept in the tool-room is identified by a small pasteboard check, which is kept with the respective tool. Now if a workman desires a tool he presents his identification number at the receiving window. The tool-keeper hands out the tool, transfers the tool check corresponding to the number of the workman from the *in* board to the *out* board, and on the same hook hangs the check identifying the tool. It is very obvious that, through this simple system the tool-keeper is always able to tell what tools are out, and who is using them. By keeping the tool checks in the tool-room none are lost, or carried away. When a man quits, or is discharged, he must present a receipt from the tool-keeper to the timekeeper, showing that his account with the former department is in order, before he can receive his pay. This system is very easy to install and requires but little effort to operate.

Peoria, Ill. JOHN M. KUPEL.

SIMPLE FIXTURES FOR MAKING WORMS AND WORM GEARS

In Figs. 1 and 2, at *A* and *B*, respectively, are shown a single thread brass worm and a worm gear which were made in the fixtures also shown in these illustrations. As the requirements did not demand great accuracy, the worms were turned in a screw machine and the threads cut on a hand milling machine, while the gears were punched out of flat stock and then hobbed.

The thread milling fixture (Fig. 1) has a plain block of machine steel through which a hole is bored which will just admit the worms. A part of the top of the block is removed, so that the periphery of the worm is exposed, as shown. The end view shows that the worm is held true from all sides by the walls of this block. The mandrel *E* is fitted so that it turns snugly in the hole already mentioned. In one end of the mandrel a hole is tapped to receive the screw *F*, which holds the worm firmly against the end of the mandrel. On the mandrel a thread is cut, as shown, with the same pitch as that required for the worm. Instead of the nut ordinarily used on such fixtures, a plain key *G* is used. One end of this key is filed to fit into the thread on the mandrel, the sides of the tongue being left flat. It is hardened and driven into position in the block. In the illustration the pin is seen to extend from the block. This exposed end can be gripped in a vise if necessary to adjust the tongue properly into the thread on the mandrel.

An ordinary lathe dog is used to turn the mandrel in the block and feed the worm against the cutter. If, when the cutter comes into contact with the work, the worm tends to turn, such tendency is checked by the screw in the end of the mandrel, which tightens.

The cutter is ground to the standard 29-degree angle for the job. As the milling machine with which this fixture is used, has a hand lever to move the table, it is easy to bring the work up to the cutter. The table is held against a stop while the thread is being milled.

Before hobbing, the gears are gashed on the milling machine already mentioned, in lots on a special mandrel. The hobbing fixture is shown in Fig. 2. The body is of cast iron and is made of a discarded punch holder. Into this body is fitted a post, *D*. This post has a vertical adjustment, and it is held by the set-screw shown. On the top of the post there is a shoulder on which the gear is placed for hobbing. The washer *C* is held tight against a second shoulder by the nut shown. Just enough clearance is allowed to permit the gear to turn when it is driven by the hob. The hob is used on the centers of a small lathe and is driven by an ordinary lathe dog. The hobbing fixture is mounted on the cross-slide from which the tool-post has been removed.

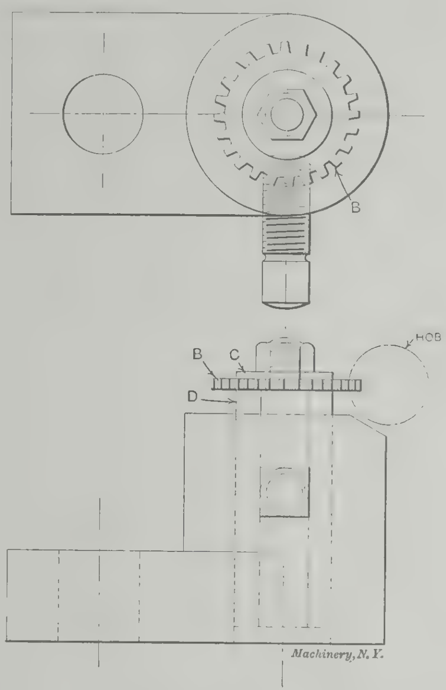


Fig. 2. Fixture for Hobbing Small Worm Wheels in the Lathe

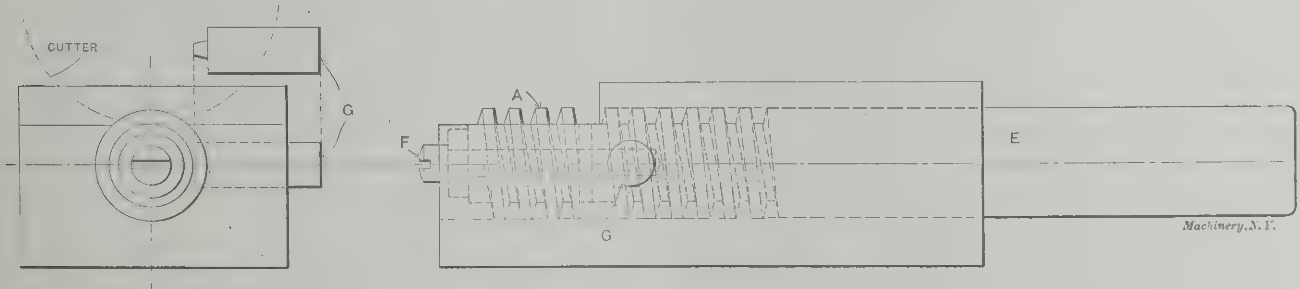


Fig. 1. Fixture for Milling Small Worms

It was found necessary to aid the hob by turning the gear with the thumb when beginning the cut, but after the gear had made one turn, the hob finished the work without further assistance. The gear was advanced toward the cutter by turning the cross-slide feed-screw. HERBERT C. BARNES.

Brooklyn, N. Y.

* * *

A side light on methods of computing charges for job work that may be useful is the practice followed by a country printer: For composition he charges two times the labor cost; for press work two times the labor cost plus 25 per cent; for illustrations, paper, etc., the charge is the cost plus 10 per cent; and all other work involving labor is charged two times the cost and 10 per cent.

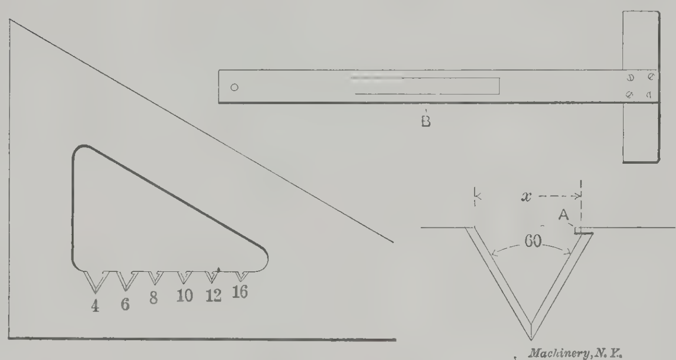
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

DRAWING OF V-THREADS

I found the drawing of V-threads to be very trying until I thought of the following scheme which makes this work much easier. The idea is as follows: File a number of 60-degree notches in the inner edge of the triangle, as shown in the illustration, for different thread pitches. Make the top width x equal to 1 divided by the number of threads per inch, and leave a small point A to stop the pencil. To use the triangle,

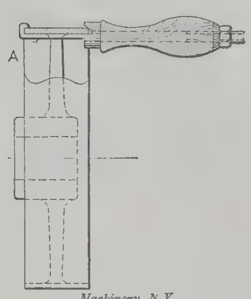


place the pencil against the left side of the notch and run it down that side and up the other to the stop; then move the triangle to the right until the pencil is again against the left side. By repeating this operation as many times as is required, a uniform thread can be rapidly drawn. Another suggestion for draftsmen is to have a 12-inch scale fastened to the T-square as shown at B. This is also a time-saver, as the scale is in a position where it is always ready for use.

Plainfield, N. J. JOSEPH WEANER.

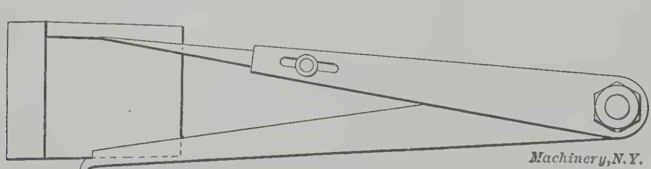
REMOVABLE PULLEY HANDLE

When a new machine is being built it is often necessary to revolve the feed or other pulleys by hand in order to observe the working of the machine. The removable handle shown in the engraving is extremely useful, as it may be attached to the rim of the pulley which is to be turned, thereby making the operation easy. The hook-bolt A passes under or over the pulley rim and through the handle, and is secured by a nut, as shown. The bolt is made long enough to suit various widths of rims and the ferrule is notched to grip different thicknesses. For pulleys with flanges another type of handle may be used in which a hoop-iron strap passes around the rim of the pulley, the handle being attached to the hoop iron. BRUM.



NEW STYLE OF HERMAPHRODITE CALIPERS

The illustration shows a pair of hermaphrodite calipers, which seems to me to be an improvement, at least for a large class of work, over the style generally used. As will be seen the notch in the end of the caliper leg makes it much

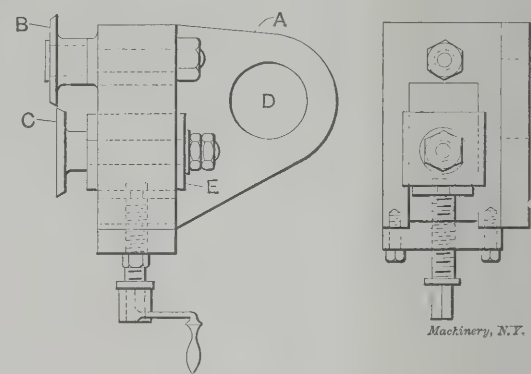


easier to scribe a line parallel with a finished edge, since the point of contact which this leg makes with the finished surface as the calipers are drawn along, is kept the same. The curved extension will also be found useful in laying out work.

Dayton, Ohio. J. L. MARSHALL.

TOOL FOR TRIMMING THIN TUBING

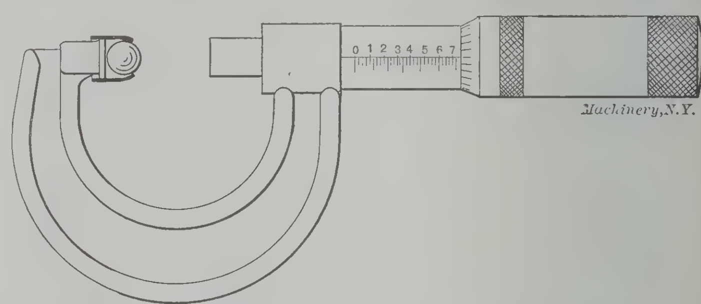
We had a number of large, drawn steel shells of about 26 gage, that had to have the ends trimmed. The metal was too thin to permit the use of a single cutting tool in the lathe, so a tool similar to the one illustrated herewith was made. It consists of a cast iron frame A, and two cylindrical cutters



B and C. The hole D through the casting A fits the tool-post of the lathe, and the fixture is clamped by passing a piece of steel through the tool-post and tightening it against the casting. Cutter B is free to revolve on a fixed stud, while cutter C is carried in a sliding box E, thus permitting it to be fed in toward B by the handle shown. When trimming the end of a tube the tool is set so that the cutter B just touches the inner side of the shell. Cutter C is then fed against the outside, and the tool makes a clean smooth cut. W. ALTON.

A MICROMETER ATTACHMENT

The engraving shows an ordinary micrometer with an attachment for measuring the thickness of metal shells or other irregular pieces of metal. A piece of brass tubing is reamed cut to make a sliding fit on the anvil of the micrometer.

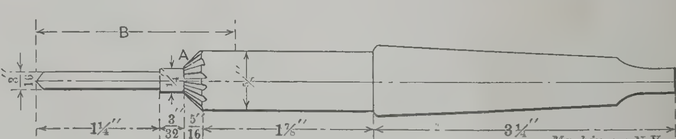


This tubing holds loosely a ¼-inch bicycle ball, which extends beyond the end of the tube, the latter being bent over to prevent the ball from falling out. The reading, of course, will be taken from the 0.250 inch graduation as zero. Bicycle balls of this size are true to 0.0001 of an inch.

Candiac, Canada. S. A. McDONALD.

HARDENING A SMALL DRILL AND COUNTER-SINK

The combination drill, counterbore, and counter-sink shown in the illustration had, of course, to be hardened. This was rather a ticklish job as the drill is so much smaller than the counter-sink, that hardening it in the usual way would mean that the drill would be at a white heat before the large part would be cherry red. To overcome this difficulty, I obtained



a fair-sized raw potato and pressed it onto the drill up to the part marked A. The tool was then placed in a slow fire and the ⅝-inch part heated, the water in the potato keeping the small part cool. When the counter-sink was heated sufficiently, the potato was removed, thus allowing the heat to run from the large part to the drill. When all was an even cherry red, the tool was cooled and the hardening was accomplished without any difficulty. JOSEPH WEANER.

Plainfield, N. J.

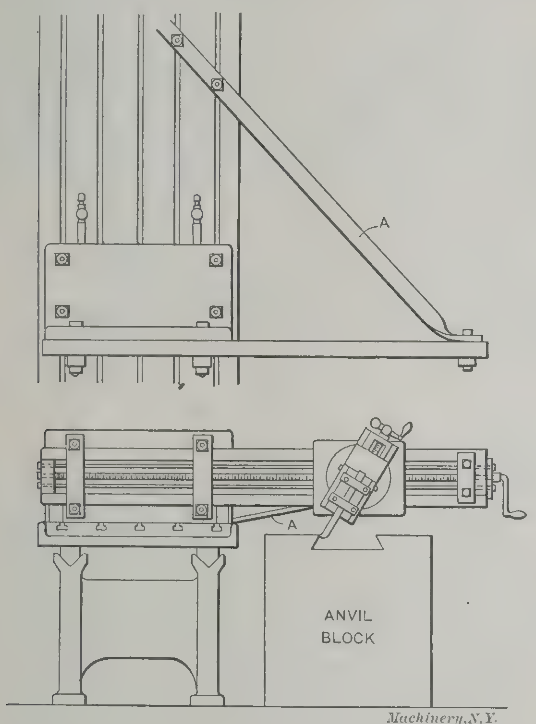
TO OBTAIN THE LENGTH OF STOCK FOR BANDS

A machinist was trying to shrink a band around the hub of a cracked pulley. He first measured the diameter of the hub and multiplied it by 3.1416 to get the circumference. The blacksmith was then told to cut off a piece of ¼-inch steel stock equal to the length of the circumference of the hub. When the band was formed to the diameter of the hub, the ends were ¾ inch apart; that is to say, they did not come together by that amount. The machinist could not understand how he had made the mistake. By the use of the following rule, trouble of this kind will be avoided: Multiply the diameter of the hub by 3.1416 and to the product add 3 times the thickness of the metal used for the band. JOSEPH WEANER.

Plainfield, N. J.

PLANING WORK THAT IS TOO LARGE FOR THE PLANER

The accompanying line engraving shows how a steam-hammer anvil-block that was too large to go on the planer, was machined. The block was first leveled up on the floor beside the planer, so that the top of the casting was a little below the top of the planer platen. For safety the casting was clamped to the floor, although its weight was such that there was no great danger of its moving under the thrust of the cut. The cross-rail with the attached head was then removed and clamped securely to a heavy angle-plate, which was bolted to the platen. A substantial diagonal brace A was then fastened to the cross-rail and platen as shown. The tool was fed, of course, by hand, and the dove-tail for the dies was planed by the use of the adjustable head in the usual manner. The job was satisfactory in every way and caused considerable comment in the shop. FREDERICK SEABURY.



Chicago, Ill.

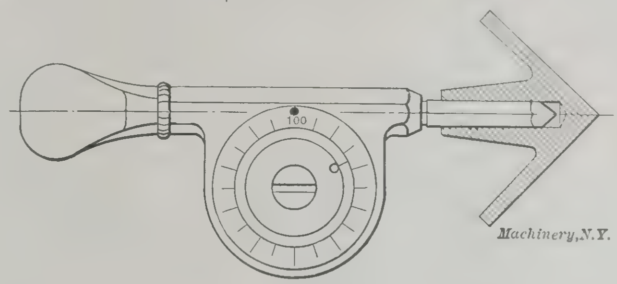
SUBSTITUTE FOR METAL WHEN MAKING ACCURATE LAY-OUTS

When making accurate lay-outs on metals, such as brass or zinc, to avoid troublesome and time-consuming calculations, I find the following objections: The needles of the drawing instruments become dull; the lines cannot be erased, and they are not very plain, especially if the metal is not coated or prepared in some manner; and the metal cannot be fastened or worked upon as easily as paper. To overcome these objections I have used as a substitute for metal what is known as filler board. This is a kind of heavy paper which looks somewhat like leather and has a mottled surface. It is often used for covers on cheap memorandum books, and is about 1/32 of an inch thick. Before lines are drawn on the surface of this board, the gloss should be removed with an eraser. The board has a good, firm body, and therefore a fine center can be made in it from which several circles can be drawn without appreciably enlarging or injuring it. Like other materials in the paper line, filler board will change slightly on account of variations in the temperature and atmosphere, and for this reason the measurements should be marked on the drawing as soon as it is made to avoid any possibility of slight errors due to changes. Where extreme accuracy is required and the nature of the lay-out is such that measurements cannot be marked to advantage, metal is advisable, especially if the drawing is to be kept for a considerable length of time as a record or for reference. H. R. ASH.

Chicago, Ill.

SPEED INDICATOR ATTACHMENT FOR SCREW MACHINE

It was necessary to determine the spindle speeds of a large number of screw machines which were operating on a wide variety of work, ranging from ¼ to 1¾ inch in diameter, and it was desired to get the speeds more accurate than would be possible by simple measuring pulleys and calculating the speeds from the speed of the line-shaft. The following method

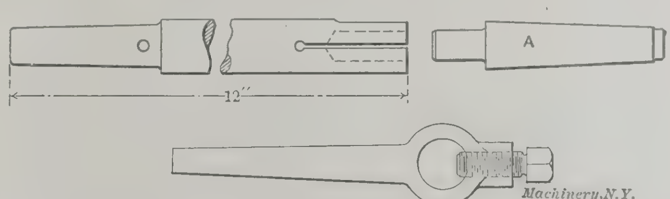


was tried with satisfactory results. An ordinary speed indicator was fitted with a brass conical tip 2 inches in diameter, as shown in the illustration. This tip was made a tight fit on the indicator spindle and was turned out to reduce the weight. To keep the indicator from slipping, three grooves 1/16-inch deep were cut radially in the conical surface and pieces of rubber peened in. In order to secure satisfactory results the indicator should be used when the feed tube is nearly empty, or just after the stock has fed into the tube; then the tip of the indicator will center in the tube and the correct spindle speed is easily taken. In this way accurate results are obtained, because there is no error due to slip of belt or variation in size of pulleys. By watching a group of machines and taking the speeds as the stock runs out, the time consumed is not as great as with the usual method of measuring pulleys and figuring from the line-shaft speed.

Indianapolis, Ind. C. C. MYERS.

ARBOR FOR SHELL REAMER

The engraving shows an arbor for a shell reamer, which is so designed that it will not creep off of the tail center and crowd into the work, as is the case when the arbor is held directly against a cone center. This arbor has a hole drilled in the end about 1¼ inch deep in which is fitted a special tail center A, having a straight portion about 1 inch long.



The end of the arbor is sawed through so that it grips the center when a dog is placed on it and tightened. Even without the split end there is no tendency on the part of the arbor to work off the center A since the upward thrust on the center (equal to the downward thrust on tail of the dog) has no horizontal component. There is also a special straight-tailed dog to go with the arbor, but this is not really necessary. The diameters of the holes in ends of all arbors are made the same. Since adopting this form I have had no difficulty with bent arbors, broken centers, broken shell reamers and inaccurate holes. W. A. KNIGHT.

Columbus, O.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

DESIGN OF MACHINE LEGS

C. E. F.—Is the design of machine legs based on empirical rules or theoretical assumptions? I have given the matter considerable thought and have been unable to arrive at any definite conclusion from a study of existing designs.

A.—It is generally conceded that design of machine legs which shall have a pleasing appearance and fulfill their purpose is one of the most difficult parts of machine design. There are no empirical rules of general application or theory of design that provides for grace of outline as well as proper support. The function of the legs should be that of supporting the machine and transmitting its vibrations to the foundation, especially in the case of machine tools. The tendency of modern design is to eliminate the legs entirely and carry the frame to the floor or foundation. This form avoids the troublesome feature of proper leg design and increases the solidity and rigidity of the frame by deepening it and more closely associating it with the foundation.

ANNEALING AIR-HARDENING STEEL

F. T. M.—I would like a reliable method of annealing air-hardening steel so that I can drill holes about 3/32 inch diameter 2½ inches deep, and tap same to a depth of about ½ inch. The brands of steel that I have tried are refractory, and it has been found impossible to anneal them so that the drills will stand up. I have tried a certain brand of high-speed steel drill but the results are about the same as with regular drills.

A.—We are unable to suggest any but the well-known method of annealing air-hardening steel by using air-tight receptacles in which the steel is packed with lime, sand, ashes or other neutral material; and heating the box and contents to a full red heat for a number of hours, depending on the size of the box and stock, and allowing the whole to cool down slowly. The question is referred to the readers for answers and suggestions. Many, no doubt, will highly appreciate a description of a method of annealing air-hardening and high-speed steel that is superior to the common method in use.

CUTTING SPEEDS

F. W.—Please state the proper cutting speeds for both carbon and high-speed steel tools, cutting tool steel, machine steel, cast iron and brass, in different machines.

A.—The proper cutting speed depends on several factors besides the kind of material to be cut and the kind of steel used for the cutting tool. The depth of the cut, the feed, and whether roughing or finishing, also influence the cutting speed. For general purposes the table above, however, referring to regular carbon tool steels, will be found to give figures representing good average practice. For high-speed steel tools these speeds may be at least doubled. The Cleveland Twist Drill Co. recommends for high-speed steel drills a cutting speed of 50 to 70 feet per minute for machine steel; 60 to 80 feet per minute for cast iron; and 100 to 140 feet per minute for brass, when starting the drill. When a few holes have been drilled at these speeds, still higher speeds may be employed, as the drill point is then heated and high-speed steel tools have a higher cutting capacity when heated than when cold. At the W. G. Armstrong, Whitworth & Co. works of Manchester, Eng., a cutting speed as high as 160 feet per minute for turning machine steel and 150 feet per minute for milling machine steel with high-speed steel tools and cutters, has been employed successfully.

TABLE OF CUTTING SPEEDS IN FEET PER MINUTE

Carbon Steel Tools

Machine	Material			
	Tool Steel, Annealed	Wrought Iron and Mch. Steel	Cast Iron	Brass
Lathe, planer and shaper	18 to 25	30 to 40	40 to 50	80 to 125
Milling machine	25 to 35	35 to 45	40 to 60	80 to 120
Drill press	20	30	35	60

A PROBLEM INVOLVING MOMENTS OF FORCES

B. R. E.—A window cleaner sets an eight-foot ladder weighing twenty pounds against a plate glass window with the foot of the ladder two feet from the plane of the window glass, and climbs to a height of three-fourths of the ladder's height. If he weighs 150 pounds, what is the horizontal pressure against the glass window when he stands erect without touching the glass?

A.—In the accompanying illustration, AB represents the ladder, the length of which is 8 feet; BC is the plate glass window; the lower end A of the ladder is placed 2 feet from the plane of the window. Four forces act on the ladder, *viz.:* the reaction P at the upper end, at right angles to the window plane; the weight W of the window cleaner, acting vertically downward at a point three-fourths of the ladder's height from the ground; the weight W_1 of the ladder, concentrated at its center and acting vertically downward; and the reaction R at the foot of the ladder acting vertically upward.

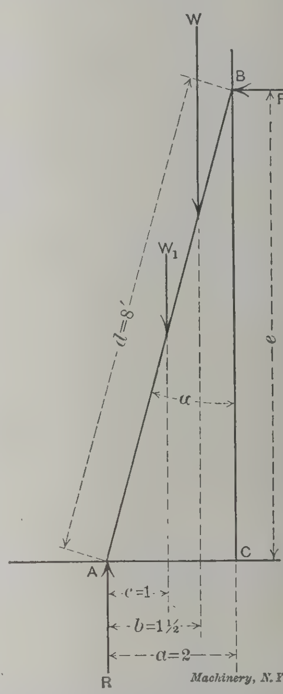


Diagram showing Forces Acting on Ladder

In order to arrive at a universal formula, let the various dimensions be represented by a, b, c and d, as shown in the illustration. To find P, find the moments of the forces relative to point A. The moment of force R relative to this point $= 0$. Hence, the moments of W and W_1 must balance or equal the moment of P. Therefore:

$$Wb + W_1c = Pe.$$

But $e = a \cot \alpha$; consequently

$$Wb + W_1c = Pa \cot \alpha,$$

or

$$P = \frac{Wb + W_1c}{a \cot \alpha} = \frac{Wb + W_1c}{a} \tan \alpha.$$

If we now insert the given values for the various quantities, we have:

$$P = \frac{150 \times 1\frac{1}{2} + 20 \times 1}{2} \tan \alpha = 122.5 \tan \alpha.$$

As $\sin \alpha = \frac{2}{8} = 0.25$, $\alpha = 14° \; 29'$. Tan α, then, is 0.25831, and

$$P = 122.5 \times 0.25831 = 31.64 \text{ pounds.}$$

This is the pressure due to the combined weight of the window cleaner and ladder, tending to break the glass.

* * *

It frequently happens that a babbitt-metal is required intermediate between the well-known genuine mixture and the cheapest grade in which nothing but lead and antimony is used. As the market price of tin is always high, genuine babbitt is often too expensive for many consumers to employ. The following mixture, given in the *Brass World*, will serve in instances where an intermediate grade is desired:

Lead	50 pounds
Tin	35 pounds
Antimony	15 pounds

This mixture has the advantage of containing no copper, and, therefore, is easily made in an iron kettle. It is not only intermediate in quality but in price as well. It is better than the lead and antimony mixtures, and is only slightly inferior to genuine babbitt. Many large machine builders now use it with good results where genuine babbitt was formerly employed.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

LE BLOND HEAVY-DUTY ENGINE LATHE

The accompanying illustrations show a general view and details of a 20-inch heavy-duty engine lathe recently placed on the market by the R. K. LeBlond Machine Tool Co., 4609 Eastern Ave., Cincinnati, Ohio. This is one size of a line of lathes of the same type, including 16-inch, 20-inch, 24-inch and 30-inch lathes. The principle on which these machines have been designed has been to furnish a tool capable of taking a given cut and removing a given number of cubic inches of metal per minute. The 20-inch lathe shown in Fig. 1, for example, is capable of taking a cut ¼ inch deep with a feed of 1/6 inch at a cutting speed of 65 feet per minute, in 50-point carbon steel. This is equal to removing 32 cubic inches of metal per minute. While the new ideas incorporated in the design of this new line of lathes do not involve radical departures from the company's previous designs, an effort has been made to increase the productive capacity of the machine in all respects. At the same time, the manufacturers have aimed to produce a machine without complicated detail arrangements, so that it would be easily operated, and remain rigid even under heavy stress.

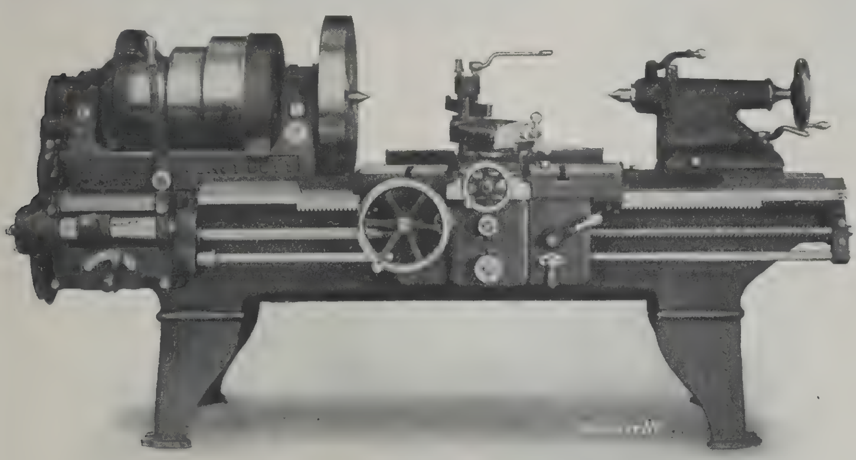


Fig. 1. R. K. Le Blond Machine Tool Co.'s 20-inch Heavy-duty Engine Lathe

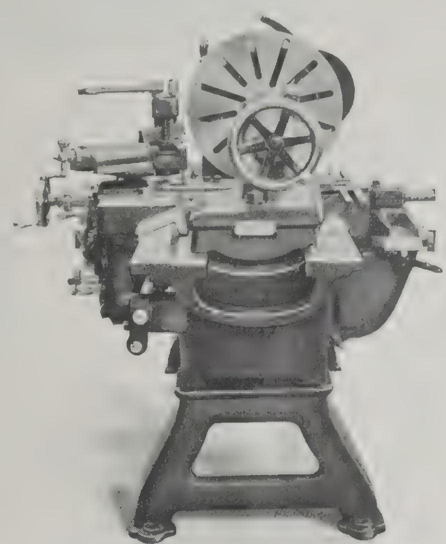


Fig. 2. End View of Lathe

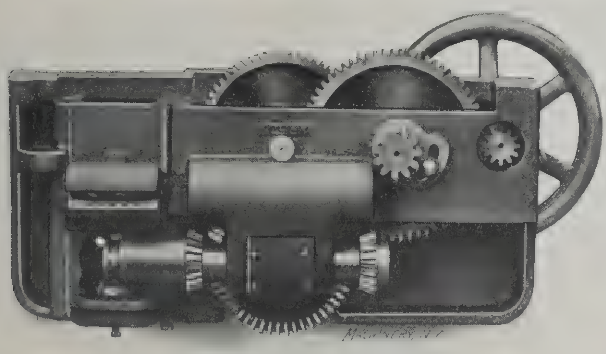


Fig. 3. View of Apron, showing Construction

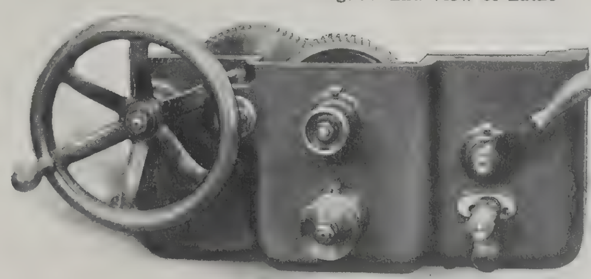


Fig. 4. Front View of Apron

The Head-stock and Tail-stock

The head-stock is of the LeBlond improved drop braced pattern and is securely fastened to the bed with bolts of large size. The three-step cone pulley in conjunction with the double friction back-gears and a two-speed countershaft, provide, in all, eighteen changes of spindle speeds, covering a range carefully selected for the purpose of the machine. The spindle is hollow and made of high carbon hammered steel, and is hardened and ground at the front and rear journals. These latter are carried in cast iron boxes scraped to a good bearing fit. This type of bearing the builders consider preferable, because it does not require intricate oiling devices with continual attention on the part of the operator; yet the lubrication is well taken care of. The bearing standards are cored out to form large oil chambers which are filled from the front of the lathe; from these the oil is fed to the bearings by means of felt pads. This construction eliminates all possibility of grit and dirt entering the bearings, and reduces the attention required to filling the oil receptacle once a week.

The tail-stock is of massive design with a bearing of ample length on the bed. The tail-spindle barrel is designed in such manner as to give the maximum length of bearing combined with long travel. Screws are provided for setting over the tail-stock for taper work, the base being graduated so that this setting can be easily accomplished.

The Bed

In the end view of the lathe, Fig. 2, the form of bed, which is a new departure, is clearly indicated. The tail-stock slides on a V of the usual proportions on the rear way, and on a flat surface in the front. The carriage travels on a flat surface in the back, as shown, and is held down in the back by a flat gib. The front of the carriage slides on a guide of different shape from that usually found in engine lathes. This guide, as shown, is V-shaped, but is machined at an angle of 15 degrees on the front side, and 70 degrees on the back, making the total included angle 95 degrees. The force exerted downward on the carriage of an engine lathe is many times greater than the upward pressure, and in designing the lathe bed this fact has been given due consideration, the wearing surfaces, therefore, having been proportioned accordingly, as shown.

The bed, in addition to having an unusually deep section, is reinforced and braced by a transverse rib of an I-beam section directly under the front bearing; this rib extends up to the extreme top of the bed. In addition to this, the metal around the holding-down bolts for the head has been reinforced to about three times the thickness usually found at this place.

The Carriage and Apron

The carriage is held in alignment on a scraped surface on the front of the bed by taper gibs at both end bearings. This

construction, together with the 70-degree angle on the back of the V overcomes any tendency of the carriage to climb the ways when the lathe is engaged on heavy work. The gibs are tongued in position in the carriage, and in combination with the special construction of the V, they automatically compensate for the wear; this makes it unnecessary to give any attention to the adjustment of the gibs. Wipers are provided, fitted with felt pads, which in addition to wiping off chips and grit from the sliding surfaces also provide for automatic oiling of the ways.

The line engraving, Fig. 7, shows a cross-section through the bed, carriage, apron and taper attachment. This engraving indicates clearly the proportions of the shears, and shows also the relative position of the lathe spindle to the bed. The spindle, as will be noted, is set back a certain distance (in this size of lathe two inches) from the center of the shears, which construction not only provides for an increased swing over the carriage, but at the same time permits the machine to be used at full swing without the tool overhanging the bed, a construction which adds greatly to the rigidity of the machine when turning work of large diameters.

Figs. 3 and 4 show a front and rear view of the apron. From these illustrations it will be seen that the apron is constructed of a one-piece box section casting, with all gears and studs supported at both ends. The apron has a wide bearing on the carriage, is held in position by four bolts, and is fitted to the carriage by means of a tongue. The single box section form of the apron, it is stated by the manufacturers, does away with the necessity of an auxiliary support at the lower end of the apron, and overcomes the difficulty of uneven wear between the lower slides and the V on the top of the bed.

The longitudinal and cross feeds are operated by a single friction which, in addition to being of large diameter, is so placed in regard to the gearing that it has but a light duty to perform. The feeds are engaged by an inward or outward movement of the knob of the lever shown on the front of the apron in Fig. 4. This lever has a central position, which disconnects all gearing when the lathe is used for screw cutting. The apron is further provided with a device which makes it impossible to engage the feed rod and lead-screw at the same time.

Change Gear Box

The quick change gear box supplied with these lathes is shown in Figs. 5 and 6, the former showing the gear box ready to be assembled to the lathe, while the latter shows the gearing, the front cover having been removed. The entire mechanism is completely self-contained. Nine changes of speed for the lead-screw are obtained by means of the cone of gears shown and the tumbler. The tumbler gear, as will be seen, is supported on a cylindrical bearing, and is securely locked in position by the plunger in the change handle. This construction is the same as has been used on the LeBlond lathes for some time. The nine changes mentioned above are quadrupled by the addition of a sliding gear transmission, which is illustrated in Fig. 6. The gears of this sliding transmission are operated by the lower lever shown in Fig. 5. This construction permits of the use of a speed or index plate which reads directly, and from which the operator can see at a glance the position of the levers required for any desired speed. The changes can be made while the lathe is running under the heaviest cut. The gears in the gear box as well as all other feed gears are made from drop-forged steel blanks. The feed rod is driven by the same mechanism by means of gears connecting it with the lead-screw, the range of feed being from 8 to 120 per inch. The changes for the lead-screw provided by the gear box are thirty-six in number, ranging from 2 to 30 threads per inch.

The feed box is connected to the spindle by means of gears, the intermediate one of which is mounted on a quadrant, which permits the use of compound gearing at this point if required for cutting special or metric threads with a standard English pitch lead-screw. A metric pitch lead-screw can also be supplied, in which case the gearing arrangement permits of cutting English pitch threads with this screw, by using compound gearing in the same manner.

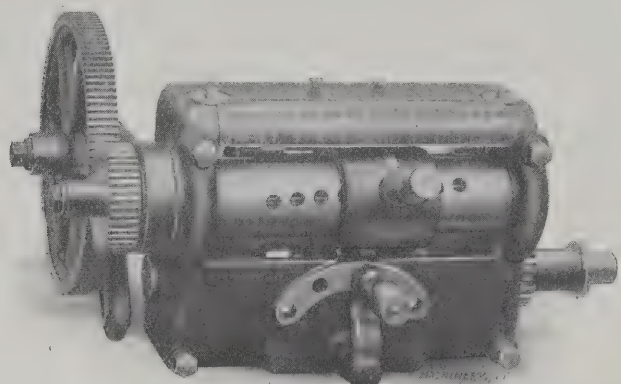


Fig. 5. Gear Box, complete, ready to be Applied to Machine

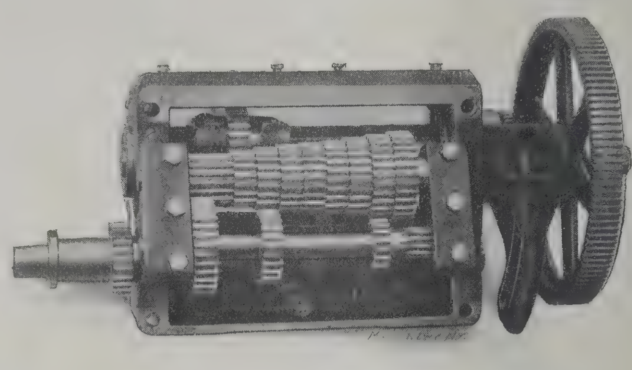


Fig. 6. Arrangement of Gearing in Gear Box

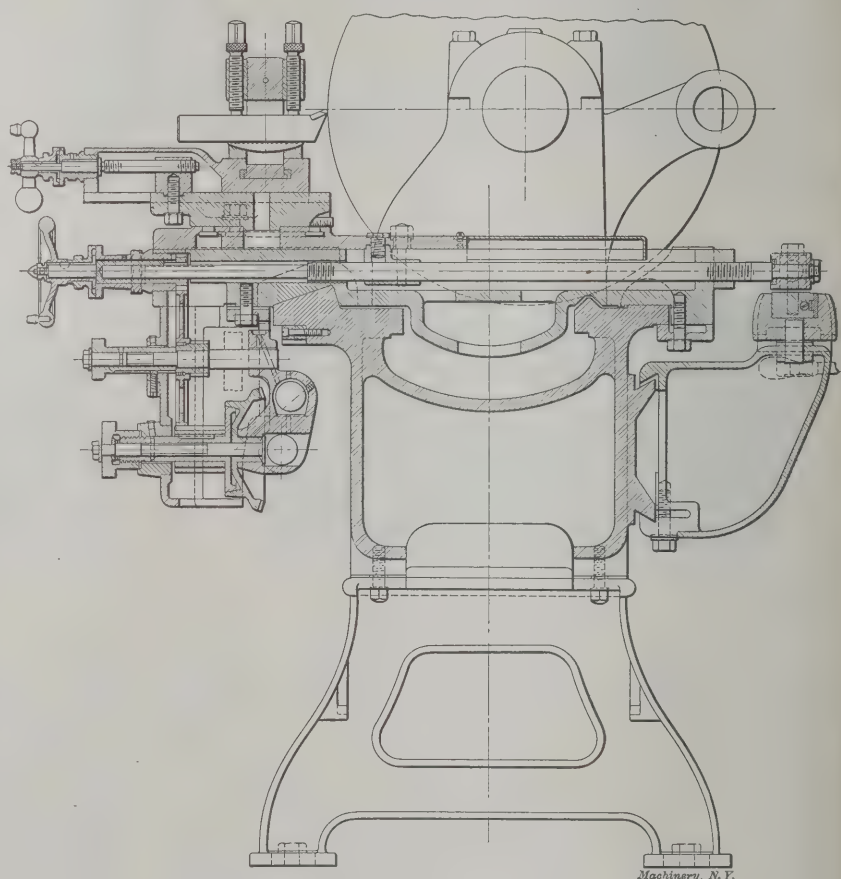


Fig. 7. Cross-section through Bed, Carriage and Apron of Le Blond Lathe

UNIVERSAL HORIZONTAL BORING MACHINE

A universal horizontal boring machine has recently been placed on the market by the Universal Boring Machine Co., of Hudson, Mass. This machine has been built with a special view to accuracy and permanence of alignment, and is known as the No. 2½ universal horizontal boring machine with extra long bed; this latter feature facilitates the machining of large castings. The machine is especially adapted to jig work and similar operations where it is necessary to do very accurate boring, milling and drilling, the machine itself being used for obtaining the various distances between the centers of the holes.

A general view of the machine is shown in Fig. 1. As will be seen from this illustration, the machine is of the constant belt speed gear-driven type. The bed of the machine is of a deep box construction, and is heavily ribbed on the inside to insure rigidity, which is one of the most essential features in machines of this type when accurate results are required. A heavy bed also gives a solid foundation to all the different parts mounted on it, keeping them in accurate relation to each other in all positions, and eliminating the necessity of building a foundation under the machine. Due to the fact that a foundation is not necessary, the location of the machine is not confined to the ground floor. The bed rests on three points, making it very easy to level up on uneven floors; at the same time undue strain on the bed, due to imperfect support, is eliminated.

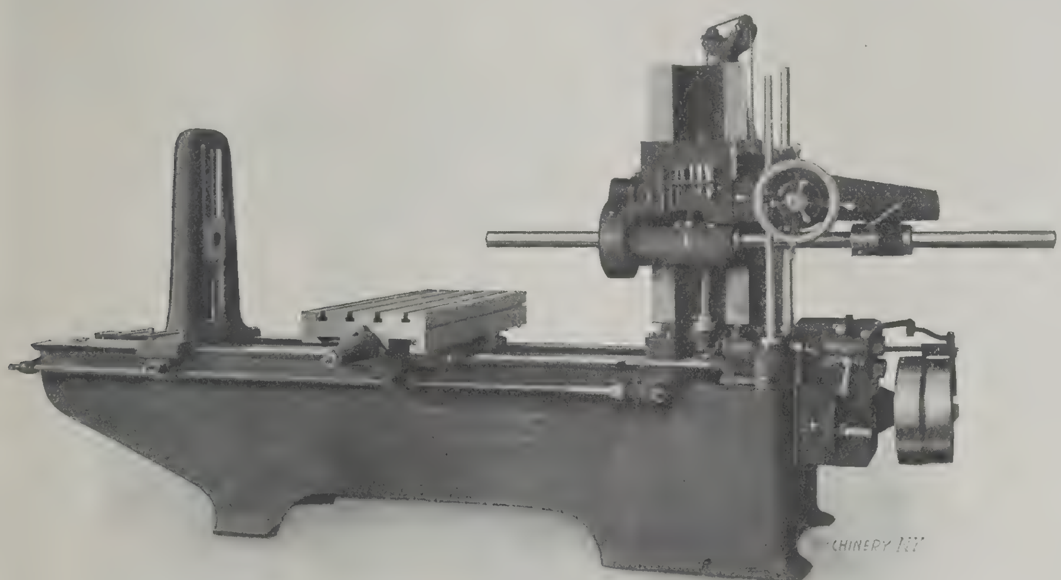


Fig. 1. Universal Boring Machine Co.'s Horizontal Boring Machine

Head and Driving Mechanism

One of the prominent features of the machine is embodied in the placing of the head at the right-hand end of the machine. This arrangement permits the spindle to run in the same direction when milling as when boring and drilling. The hand-wheel for the rapid adjustment of the spindle is placed on the head conveniently in relation to the spindle where the cutter is mounted, thus allowing the operator to see the milling cutter and to make adjustments at the same time. In the line engraving, Fig. 4, is shown a cross-section of the head and the feed and speed gear box. It will be noted that the machine is provided with a power vertical feed to the head, employed when milling, which for many classes of work is a very valuable feature. Aside from the regular vertical milling feed, the head has a power feed raising and lowering device. A hand feed for fine adjustment of the head by a micrometer dial graduated to thousandths of an inch is also furnished. The head is counter-balanced by a weight attached to a wire rope, as shown, and it is moved by a large screw of coarse pitch. Suitable arrangement has been made to oil the sliding surfaces in order to minimize the wear.

The gear box, the arrangement of which is shown in Fig. 4, is strong and compact and contains both the feed and speed change gears, which are all made of steel and run in a bath of oil to provide quiet running and long wear. Eight speed changes are secured in the gear box, and these are doubled by the back gearing in the head. There are nine feed changes in either direction for the head, one lever reversing or stopping all the feeds.

The spindle is driven at a point near to the work, and thus torsional stresses are practically eliminated. This manner of driving the spindle is of special advantage when using large milling cutters, because the chatter usually present when taking heavy milling cuts on machines where the application of the drive is some distance from the cutter, is eliminated. The driving gear has a long hub in which the spindle is inserted and held by two sliding keys. The spindle itself runs in self-oiling bearings, these bearings having an individual oil compartment containing enough oil for about twenty months running. The bronze bearings, which are fitted into the bearing proper, have a groove cut the entire length, and in this groove is laid a wick having its ends submerged in the oil compartment below. The bearing proper is also split and provided with clamp screws for taking up the wear.

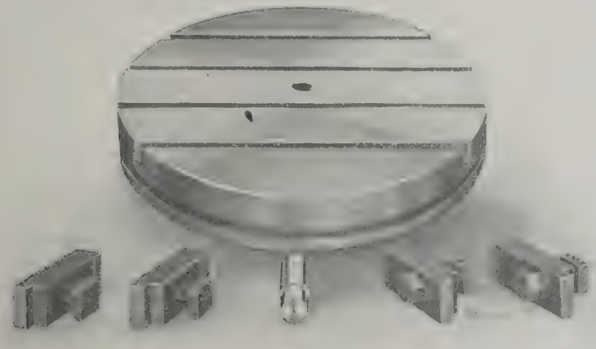


Fig. 2. Rotary Table used on the Horizontal Boring Machine

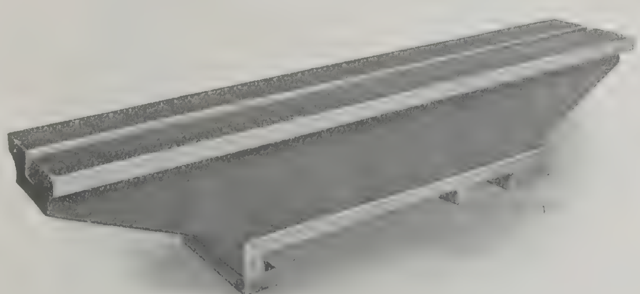


Fig. 3. Auxiliary Table used for Work which would Overhang the Regular Table

Fig. 4 also shows a cross-section of the tight and loose pulleys on the driving shaft. It will be noted that the loose pulley is slightly smaller in diameter than the tight pulley, so there is practically no tension on the belt when it is on the loose pulley, consequently there is but slight wear. The loose pulley is made in one piece and has an oil reservoir cored out around the bearing. This reservoir is filled with cotton waste and oil, and a wick is laid in a groove cut in the bearing, the ends of the wick extending downward into the oil reservoir below.

Table and Table Feed Motions

The platen or table of the machine is made especially heavy in order to avoid springing when clamping the work upon it. It is provided with power feed in either direction, and with automatic stops. The screw which imparts motion to the platen, carries a dial graduated to thousandths of an inch. The gears which drive the feed-screw are encased and run in oil. The top of the table is provided with four milled T-slots running the entire length.

The feed motion of the machine is taken from the driving shaft which runs at a higher speed than the main spindle. This arrangement, shown in Fig. 4, makes it possible to obtain nine feeds without increasing the ratio of the gearing, thus avoiding excessive stresses on the feed gears and bearings. The fine feeds are obtained by reduction gearing. Besides the table shown in place in Fig. 1, the machine is provided with a rotary table, shown in Fig. 2. This table is 24 inches in diameter and is graduated on the outside periphery to one-half degrees. The feed in both directions to the table, together with the rotary table arrangement, permit of finishing at one setting many classes of work, which would otherwise require re-setting and finishing in other machines. Holes, for instance, may be bored and drilled and surfaces milled at various angles without re-setting, thereby saving considerable time and expense in handling. In Fig. 3 is shown an auxiliary table which is used for work which would overhang the regular table. This auxiliary table has a T-slot milled its entire length as shown, and is a very essential feature in the rapid and accurate machining of large castings.

Miscellaneous Features

The outer support bearing for the boring-bars, shown in position on the bed in Fig. 1, is gibbed to the internal guiding surfaces of the support. The raising and lowering of the bearing in the support is accomplished by means of a screw connected by spiral gearing and splined shafts to the elevating screw of the spindle head, so that the two bearings for the bar move simultaneously. Provision has also been made for re-aligning the bearings in case of wear. The outer support bearing is moved longitudinally on the bed of the machine by a hand-crank. It can easily be removed from the machine, if required, by removing the bracket at the end of the bed and pulling off the supporting post, and it can be replaced in exact alignment without difficulty.

The machine is provided with extension boring-bars, and bushings to fit in the outer support bearing, and with one roughing and finishing cutter for each boring-bar. The extension boring-bars are provided with No. 4 Morse taper shanks, fitting the socket in the spindle. The spindle is provided with a slot for driving the extension boring-bars by means of two keys in addition to the usual driving tang. Two face milling cutters are also furnished with the machine, if required, one being 2 inches and the other 10 inches in diameter. The hub of the driving gear forms a face-plate to which the 10-inch face milling cutter, provided with holes for clamping screws, may be fastened. This arrangement makes the most rigid connection possible between the drive and the cutter. The smaller face milling cutter is attached to an arbor fitting the taper hole in the end of the spindle. The 10-inch cutter is provided with a center hole large enough to permit a spindle, when carrying the 2-inch cutter, to pass through it, so that either of these two cutters may be used without the necessity of removing the other.

The machine will take pieces 94 inches long between the face-plate and the outer support of the boring-bars. The greatest distance from the top of the platen to the center of the spindle is 22¾ inches. The table or platen is 20 inches wide by 42 inches long and has a cross-feed of 34 inches.

Messrs. Hill, Clarke & Co., Inc., 14 So. Canal St., Chicago, Ill., are the selling agents for this machine, and it may be seen in operation in their demonstration shops.

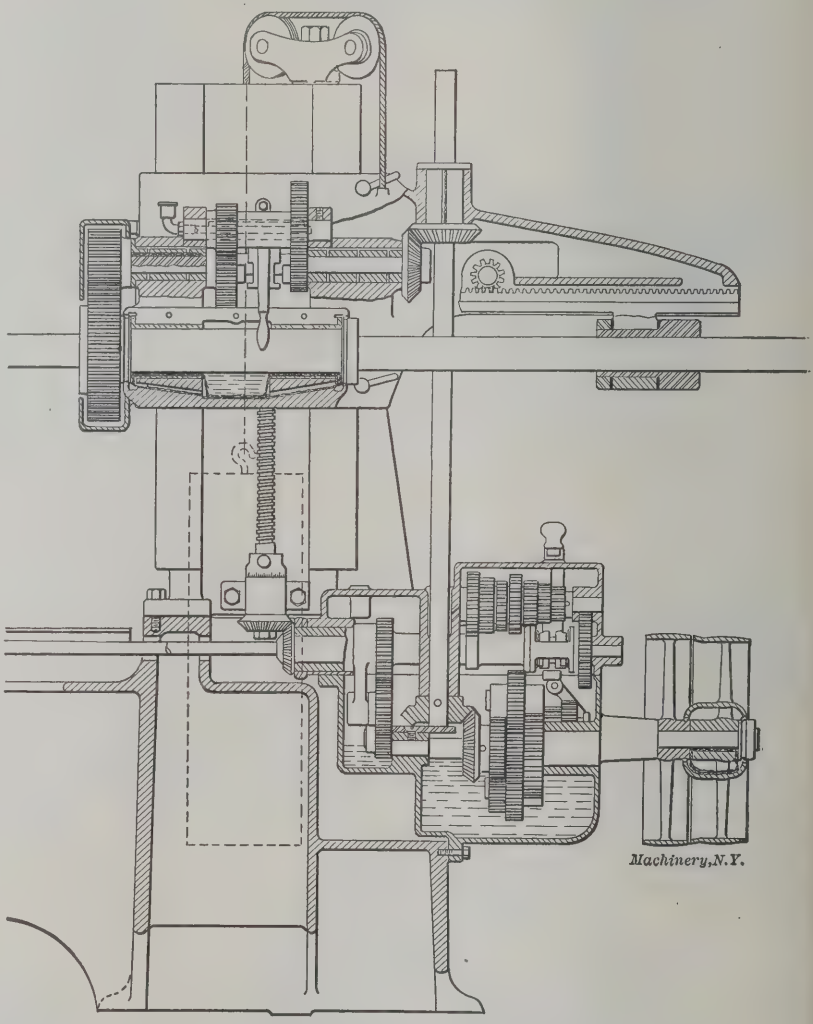


Fig. 4. Section through Head and Gear Box of Universal Boring Machine

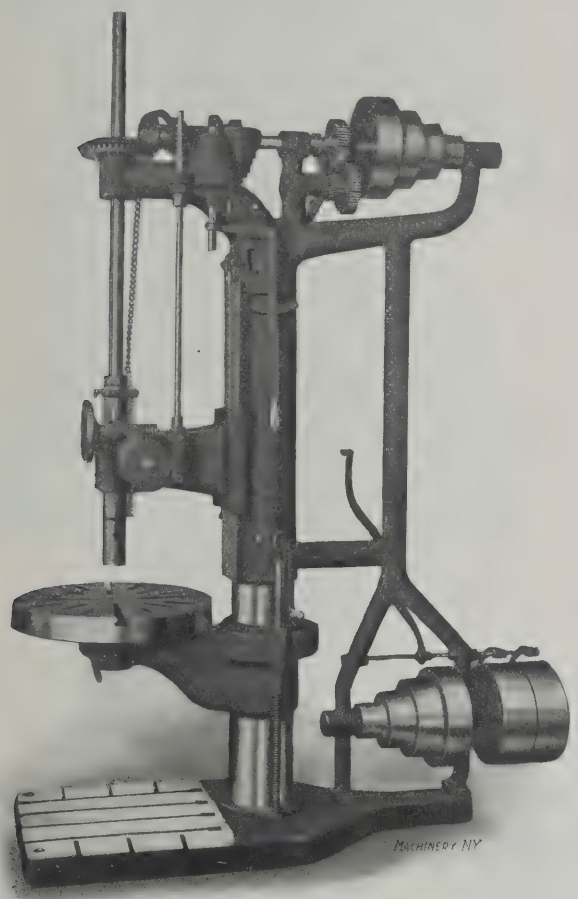
HOEFER DRILL PRESS WITH POSITIVE GEARED FEED

The accompanying illustration shows an improved drill press recently brought out by the Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill. The most important feature in this new machine is the positive power feed and the method of changing the feed. An improvement has also been introduced in the mechanism used for raising and lowering the table arm.

As will be seen from the illustration, the drill spindle is fed downward by means of a series of gears enclosed inside of a gear box at the top of the machine, which transmit motion from the main driving shaft through a worm and worm-gear to a pinion engaging a rack on the drill press spindle sleeve. Described in detail, the motion is transmitted as follows: The horizontal driving shaft at the top of the machine carries a worm which engages with a worm-wheel keyed to a short vertical shaft. To this shaft are also keyed five gears of different sizes each engaging with a corresponding gear on a second vertical shaft. The gears in the second set run loosely on the shaft on which they are mounted, except that any one can be engaged with the shaft by means of a key sliding in a spline in the shaft and the gears. By shifting this sliding key up and down, any one of the gears in the second set can be engaged to transmit motion from the first vertical shaft to the vertical feed spindle. The motion between the second vertical shaft and the feed spindle is transmitted by means of a gear keyed permanently to the lower part of the second vertical shaft, driving a gear on the feed spindle, the latter, of course, being splined so that, while its driving gear is keyed to it, it can yet slide freely. The feed spindle carries at its lower end a worm engaging with a worm-gear keyed permanently to the short horizontal shaft

which carries the pinion engaging with the rack on the spindle sleeve.

By shifting the sliding key up or down to engage with the different gears in the gear box, as already mentioned, the amount of feed per revolution of the main spindle can be adjusted as desired, five feeds of 0.006, 0.015, 0.023, 0.032 and 0.041 inch per revolution, respectively, being obtainable. The feed can be changed while drilling, by merely moving the lever operating the sliding key. The lower end of the key is attached to a collar on the second vertical shaft, previously mentioned, and the horizontal arms of the bell crank lever engages with this collar. The handle of the vertical arm of the lever is within easy reach of the operator, as shown in the



Hoefer Improved Drill Press with Positive Geared Feed

engraving, and by shifting it to various notches on the projecting boss on the side of the column of the machine, the feed is easily adjusted to any predetermined amount. The design prevents the key from engaging with two gears at once, as this would obviously cause damage to the mechanism. For this reason, a hardened tool steel ring is placed in a recess on one side of each gear, and as the key slides past this ring, it is forced back into the keyway in the shaft and out of engagement with both the gear that is being disengaged and the gear that is to be engaged. Continued movement of the sliding key will bring it into engagement with the next gear. In order to obviate any unnecessary loss of time, three keyways are provided in each gear so that the engagement is practically instantaneous.

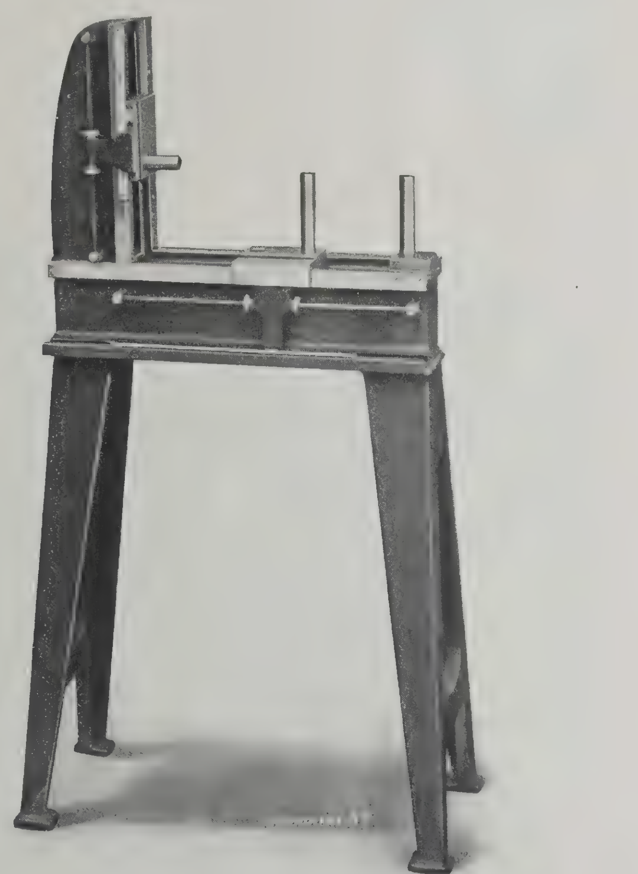
Returning to the feed mechanism on the sliding head of the machine, it should be noted that the drill or tool used can be fed by three methods, viz.: by a hand lever, by the hand worm feed, or by the power feed just described. The hand worm feed is thrown into engagement with the worm-wheel by an eccentric, while the power feed is thrown into engagement by a cam, the cam lever and eccentric being so interlocked that the engagement of both worms with the worm-wheel at one time is impossible. When passing into or out of engagement, the vertical power feed spindle swings through a small arc, but is in true alignment when in the driving position so that there is perfect mesh between the small gear by which it is driven and the driving gear on the second change gear shaft. A stop is provided by means of which the feed can be thrown out of mesh automatically at any desired point.

The improved feature for raising or lowering the table arm consists of a screw passing through a nut so arranged that it bears equally against both sides of a circular slot in the table bracket. When manufactured each machine bores the hole in its own table arm and the circular table is turned to fit the socket in the arm exactly, so that an accurate and rigid bearing is provided and, at the same time, perfect alignment of the spindle and table is assured.

The horizontal driving shaft at the top is fitted with back gears having a ratio of 4 to 1, the back gears being thrown into and out of engagement by an eccentric, as usual. The machine can be either belt or motor driven, but in either case, the driving speed can be changed, in addition to the speed change by the back gears, by means of a pair of four-step cone pulleys. The brace support at the outer end of the pulley shaft gives additional rigidity to the machine. The greatest distance from the spindle head to the base is 56 inches, and the greatest distance from the top of the table to the spindle head, 45 inches. The distance between the column and the center of the spindle is 16¼ inches. The vertical feed of the spindle is 16 inches, and the vertical motion of the spindle head 27 inches. The diameter of the spindle is 2 1/16 inches.

GEAR TESTING MACHINE

The accompanying illustration shows a gear testing machine built by the Cincinnati-Bickford Tool Co., Cincinnati, O. This machine was originally designed for the company's own use without any intention of placing it on the market; but as many of the company's customers intimated that such



Gear Testing Machine built by the Cincinnati-Bickford Tool Co.

a machine would undoubtedly meet with favor if made on a commercial basis, it has finally been decided to manufacture it for the trade. The machine is intended for testing the running of both spur and bevel gears. The gears are mounted on the removable studs shown, which are held in adjustable slides, moving freely. Provision is made for clamping these slides at any point. Each slide is capable of a fine adjustment by means of a screw and knurled nuts, the screws being seen in the illustration, one running horizontally and one vertically on the side of the machine. A vernier scale is also provided, reading to thousandths of an inch, so that

the correct center distances between the gears when mounted on the studs can be determined. The shortest distance from center to center of the two studs for testing spur gears is 2 inches and the greatest is 19½ inches. This permits of testing a pair of gears where the sum of the pitch diameters of the gears is 4 inches as a minimum and 39 inches as a maximum. The two studs for bevel gears permit of testing miter gears from the smallest made up to 18 inches in diameter, and of a combination of bevel gears where one is 4 inches and one 32 inches in pitch diameter. Each machine is furnished with two studs one inch in diameter, and 4 inches long above the slide. Extra studs can be furnished if required.

The slightest imperfections in the gear teeth are readily detected by this testing device and the cause can be analyzed with comparative ease. By remedying the defects, it is possible to produce gears that have a perfect bearing on the surfaces in contact, and that will run smoothly and noiselessly when in service. The net weight of the machine is 325 pounds and the floor space required, 16 by 34 inches.

QUEEN CITY DOUBLE-ACTING PRESS

A new double-acting press has recently been placed on the market by the Queen City Punch & Shear Co., 208 Lawrence St., Cincinnati, O. The machine has been designed for forming and pressing operations of various kinds in sheet metal, and is of especial value where a large quantity of duplicate work is to be done. The main feature of the machine is the oscillating table, presenting a feature whereby the operator is safeguarded from personal injury. Patents have been applied for, for such features as are new departures in this design. The general construction and operation of the machine will be more easily understood by referring to the accompanying two half-tone engravings, Figs. 1 and 2, one of which shows the front view and the other the rear view of the machine.

Two operators are required for the machine, to feed and remove the work, one standing in front of the machine and the

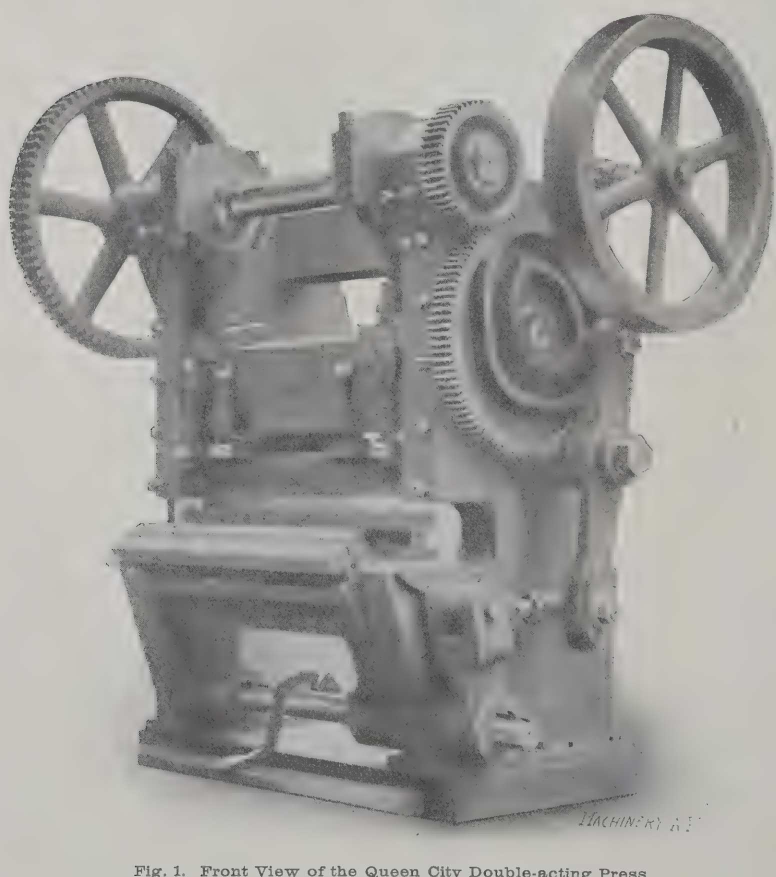


Fig. 1. Front View of the Queen City Double-acting Press

other in the rear. In the illustration, Fig. 1, the plunger or ram is shown down and the front die projects out in the front of the machine. This is the proper position of the die when the work is removed, and the die remains in this position sufficiently long without motion so that the operator in the front can remove the finished work and replace it with a blank, meanwhile being entirely out of the range of the plunger and without any danger of injury. The plunger then raises up and the die moves in under the ram for pressing or

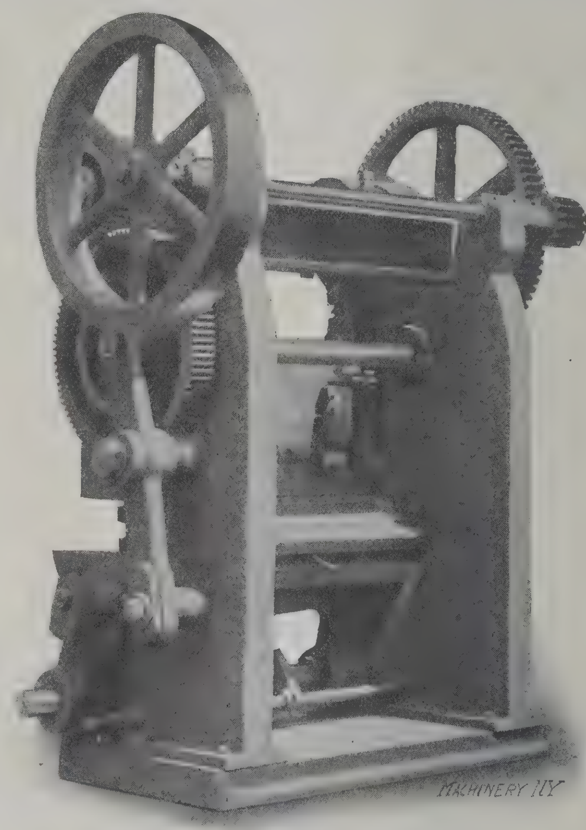


Fig. 2. Rear View of Double-acting Press

forming the blank just inserted. While this is being done the rear die projects outward in front of the operator in the rear, see Fig. 2, who then removes the finished work from this die and replaces it with a blank. It is evident that there is no occasion for the operators to place their hands or fingers under the press plunger, and the danger thereby avoided is of equal importance to employe and employer, for while the former, of course, is the one who suffers most directly through the bodily injury in case of accident, it is also a very important feature to the manufacturer, who is continually liable for damages sustained to operators when working with machines where the operation presents a constant danger to the workman.

The machine runs continually, the movements being divided in two equal periods of time, as follows: One-half of the revolution of the cam-shaft is devoted to pressing the work in the die, removing it when finished and replacing it with a new blank; the other half of the stroke allows the filled die to enter the pressing ram; this is repeated for each of the two tables or dies, thereby making it possible to press a piece of work for every revolution of the cam shaft. There is no necessity of stopping the machine except in a case of emergency, but the machine is provided with an automatic safety clutch by which either of the operators can stop the machine at will. The speed of the machine can be regulated and is governed by the character of the work to be done and by the rapidity with which the operators can handle the finished work and the blanks.

The machines of this type are equipped with machine-cut gears and can be either belt or motor driven, as required. The machine illustrated in Figs. 1 and 2 is 36 inches between the housings and weighs 7,300 pounds. It can be built in any size required and adapted to any class of forming or pressing. The novel features introduced in the design of this machine should make it a valuable tool in the sheet metal trades, both on account of its productive capacity and the safety of operation.

COLBURN 30-INCH VERTICAL BORING MILL

A new 30-inch vertical boring mill embodying a number of interesting improvements has recently been brought out by the Colburn Machine Tool Co. of Franklin, Pa. The most prominent feature of the new design is embodied in the main

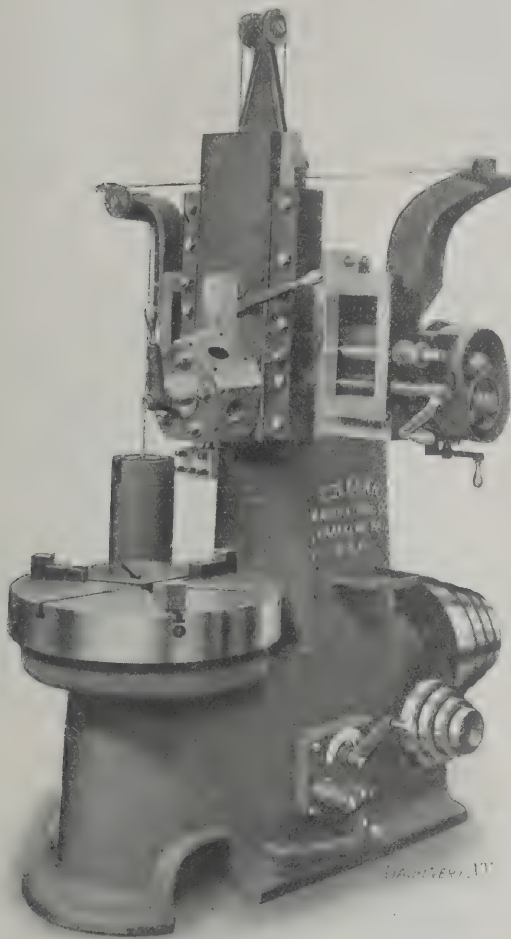


Fig. 1. Thirty-inch Vertical Boring Mill, built by the Colburn Machine Tool Co.

drive or head-stock, which is enclosed in a separate box or frame, and which can be quickly detached from the main frame of the machine and removed if required. This construction makes the assembling of the machine very convenient, and enables the proper fitting of the various parts to be done with greater accuracy. This feature is also of advantage in case of repairs, as all the parts are easily accessible and can be handled without difficulty. Another feature of special interest in the machine is the addition of a foot brake for quickly stopping the machine with the table in any desired position; this feature is not generally found on small boring mills. A general view of the machine is shown in Fig. 1, and in Fig. 2 is shown a view of the head-stock detached from the machine. In Figs. 3 and 4 are shown sectional views which give a clear idea of the construction of the machine.

As will be seen from Fig. 1, the turret is five-sided. It is set on an angle of 8 degrees with a vertical line which gives sufficient clearance for large tools when swung over the slide. The turret slide can be swiveled to any angle up to 30 degrees to either side of the vertical center line. A graduated scale with a pointer is provided which makes it convenient to measure the depth of the cut taken. The boring mill is

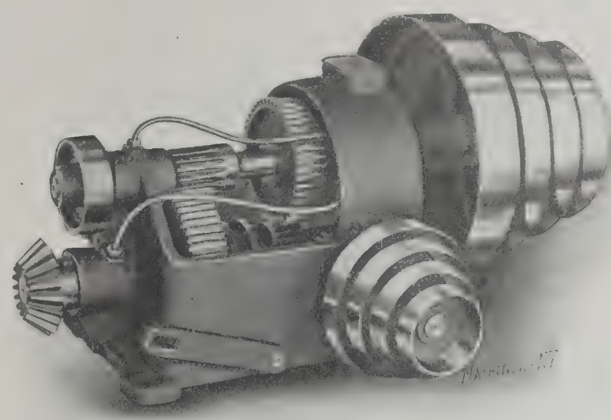


Fig. 2. Driving Head of Colburn Boring Mill

provided with a plain table having three or four chuck jaws, as required. The main spindle has sixteen speed changes, and provision is made for eight feeds vertically, and the same number horizontally. The machine is furnished with a two-speed counter-shaft.

Construction of Driving Mechanism

In Fig. 3 is shown a cross-section of the head of the machine, the table, the lower part of the frame and the driving mechanism. The motion from the cone pulley E to the table is transmitted through shaft F to which are keyed a gear G and a pinion H, which in turn drive the gears K and L. These latter two gears revolve loosely on the shaft M. A clutch operated by the handle on the outside of the frame directly above the foot treadle, as shown in Fig. 1, is provided with teeth on the face on both ends, and can engage with the clutch teeth on the sides of either gear K or L. By this arrangement two speeds are provided for, and by means of the four-step cone pulley eight speeds are obtained. The two-speed counter-shaft increases this to sixteen speeds.

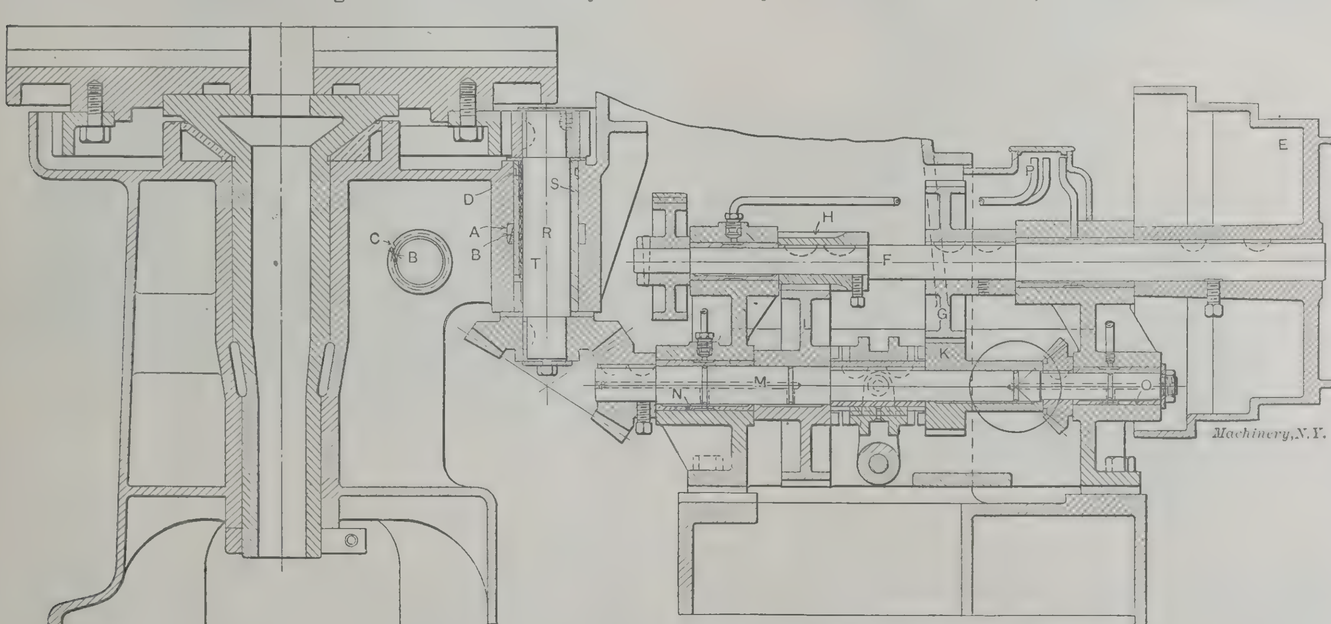


Fig. 3. Section through Driving Mechanism of Colburn Vertical Boring Mill

From shaft M the motion is transmitted in the usual manner by bevel and spur gearing to the table.

Method of Lubrication

Special attention should be called to the manner in which all running bearings are lubricated. The two gears K and L which run freely on shaft M are oiled through holes drilled through the center of the shaft M, as shown, the oil being carried to the gears from the bearings N and O. Brass tubes which all end at the common location P, under a cover provided at the top of the gear guard enclosing the head-stock gears, lead to every bearing in the head-stock. These tubes are indicated in Fig. 3 and some of them are visible in the half-tone illustration of the head-stock Fig. 2. This arrangement greatly facilitates the lubrication of the bearings, since it is only necessary to lift the cover of the guard and pour oil into all the different tubes, which here converge to one point.

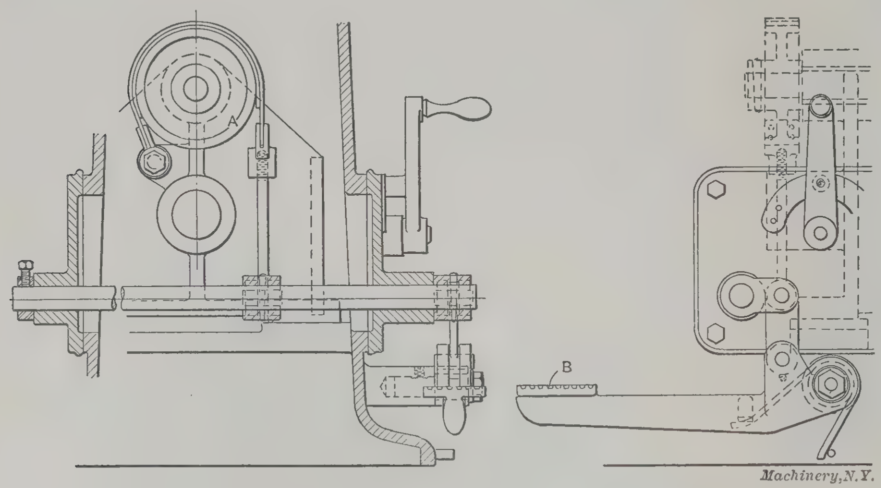


Fig. 4. Foot Brake Mechanism for Stopping the Table at any Point

The manner of oiling the bearing for the vertical shaft R is also of particular interest. This shaft runs in a large bushing S. An oil pocket A surrounds the bushing about midway of its length. This pocket is filled with oil and a wick B starts from the pocket A and leads upward through a slot C on the outside of the bushing over the top of the bushing and down through a slot T on the side of same. This method insures practically perfect lubrication, since the oil is only fed through the wick in the required quantities and in an amount determined by the amount used, on the same principle as that of an oil lamp. As long as there is any oil left in the reservoir, the wick will feed it to the bearing. Should the supply in the reservoir run out, there will always be a sufficient amount in the wick to insure the bearing running reasonably well lubricated for a long time without causing any difficulties. Oil is supplied to the reservoir A from the outside by means of the pipe shown directly in front of the tool-pan in Fig. 1. This pipe leads to annular groove D cut in the bushing S, whence it flows downward to the reservoir A. Thus, in fact, two supplies of oil are maintained, one at D and one at A, making it practically impossible for the bearing to ever become dry.

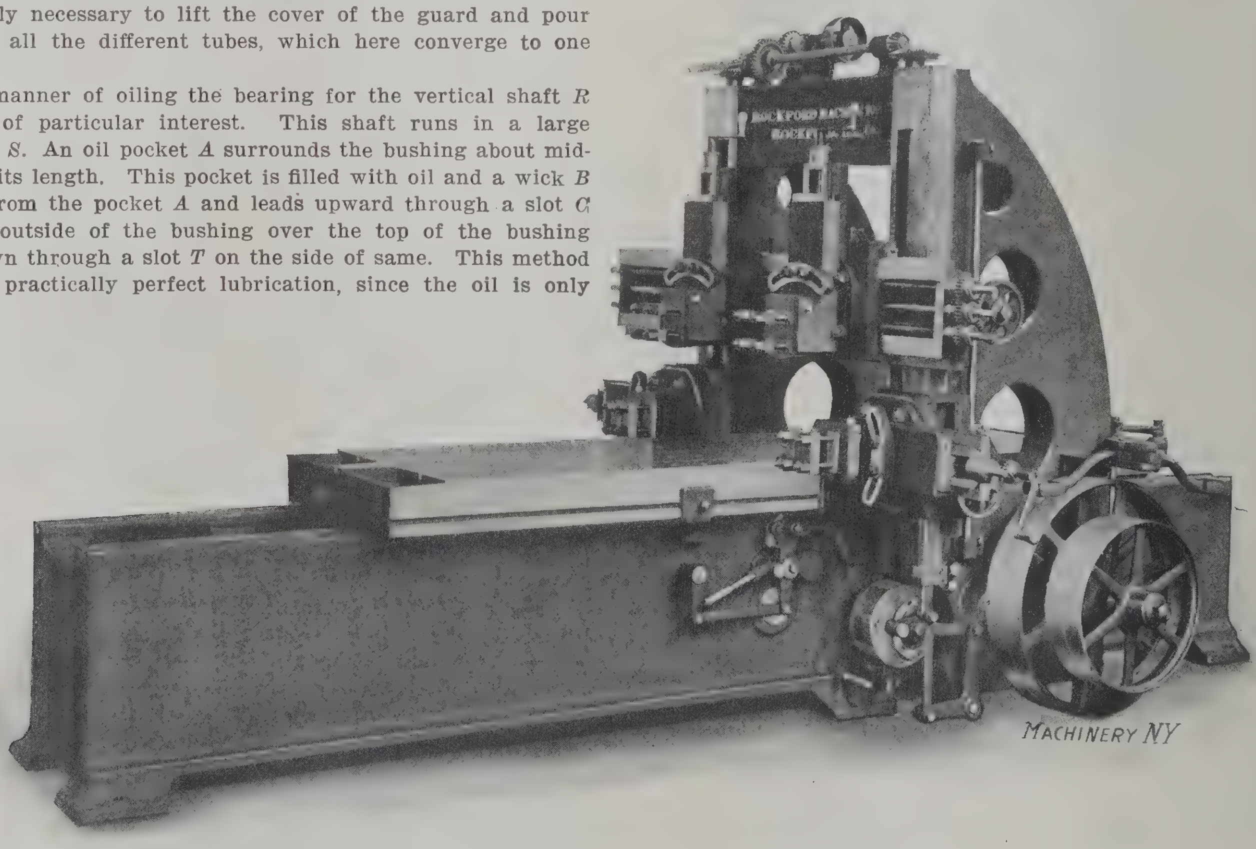
Brake Mechanism

The line engraving Fig. 4 shows the brake mechanism. The band-wheel A, which is also shown in Fig. 2 directly above the bevel gear at the left-hand end of the head-stock, is used in connection with the foot brake B for stopping the machine at any desired point. The details of the mechanism are simple in their construction, and the working of the brake can be studied without difficulty from the illustration. The leverages of the foot treadle arm are of such a ratio that considerable power is exerted at the band-wheel by even a comparatively light pressure on the treadle at B.

The new features embodied in this boring mill make it a very convenient tool, and its distinctive points will undoubtedly be appreciated by mechanics.

ROCKFORD HEAVY DUTY PLANER

The accompanying illustration shows a planer manufactured by the Rockford Machine Tool Co., of Rockford, Ill., and is known as the 32-inch by 32-inch by 8-foot heavy duty planer. This company has been for some time manufacturing planers in smaller sizes, in addition to its line of shapers, and have recently developed a full line of planers, the feature of the design of which is, in the first place, rigidity and power, while at the same time efforts have been made to maintain the smooth running qualities and the ease of operation required of modern machine tools.



Rockford 32-inch x 32-inch x 8-foot Heavy Duty Planer

As seen in the illustration, the planer is equipped with four heads of which two are placed on the cross-rail and one on each side of the machine on the housing. All the heads are provided with horizontal, vertical and angular feeds. The down feed for the heads on the cross-rail is 12 inches.

The gearing of the main drive is located inside of the planer bed between the bearings. These latter are provided with long straight bushings fitted into holes bored directly into the bed casting. The belt shifting device is of a very simple construction and reverses the table smoothly. Ample means are provided for lubrication.

The feed friction is of the combination releasing type and will carry the heaviest feeds without slipping or running warm. The feeds are changed by moving the knob shown in the illustration on the front of the friction device, a pointer indicating the feed obtained at different settings of the lever.

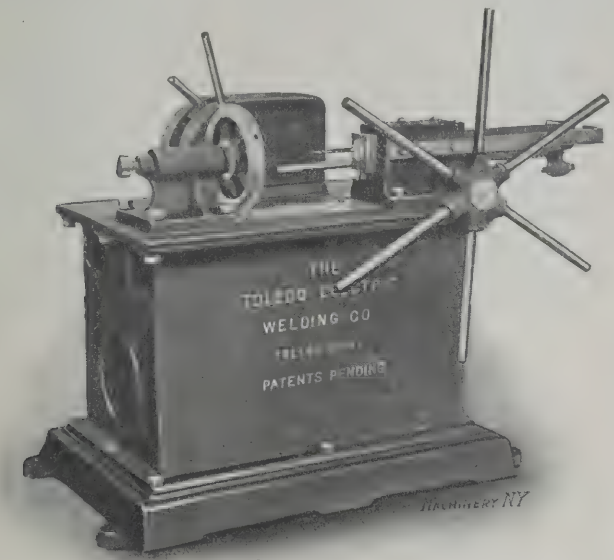


Fig. 1. Machine for Electrically Welding Small Drills to their Shanks

By means of this device the feed can be changed for the finishing cut after having rough planed a piece of work, and the lever can be instantly returned to the position for the roughing feed for the next casting. Besides the time thus gained, an additional advantage is obtained in that the operator knows exactly what feed he is using, and can get the feed he wants without making several adjustments.

All running bearings are provided with means for adjustment for wear and taper gibs are used in the slides throughout the machine so that any wear may easily be taken up in these parts. Bevel gears, pinions and feed racks are made from open-hearth bar steel. The machines are built on the interchangeable plan, and side heads can be furnished at any time to fit the machines, if not originally so equipped.

TOLEDO ELECTRIC WELDING MACHINES

The Toledo Electric Welding Co., Toledo, O., has brought out a line of electric welding machines for various purposes, three of which are shown in the accompanying illustrations. The machine shown in Fig. 1 is intended for welding small drills to their shanks, one of the drills being shown in place in the machine. The head on the left-hand end is provided with a chuck for holding the drill. Sockets are provided for different sizes of drills, and the varying lengths are taken care of by means of the adjusting bolt with a knurled head, shown at the left-hand end of the head. By this arrangement every drill projects the same distance from the clamping jaws. The shanks of the drills are held in the chuck shown at the right-hand end of the machine. The two heads are brought together by turning the spider on the right-hand head; the pieces, when brought together, are in practically perfect alignment.

The automatic switch shown at the back of the machine is adjustable and can be set to open the circuit at any predetermined point. This enables the operator to set the machine so as to make the welds with a great degree of accuracy. After the weld is made, the drill is automatically thrown out, and the chucking jaws are in a position ready to receive another drill. The operation of this machine is simple and no expert operator is required.

Fig. 2 shows a larger machine designed for welding tubing, such as automobile steering rods, etc., or solid bars up to and including 1⅛-inch round iron or steel. The stock is clamped between the copper jaws by means of the handwheels shown at the top of the machine. The right-hand head slides back and forth in ways on top of the machine bed, and is actuated by the spider shown at the right-hand end of the machine. The current is turned off and on by means of a foot switch shown on the floor at the side of the machine.

The clamping dies project far enough above the top of the table to permit bars or tubes of any length to be conveniently handled and welded without in any way interfering with

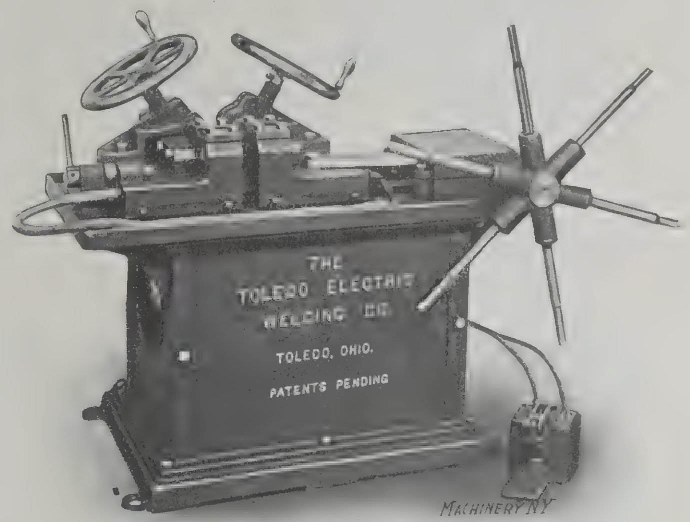


Fig. 2. Machine for Welding Tubing and Solid Stock of Large Sizes

the working mechanism. The line of thrust is in the center of the work-holding jaws, thus insuring alignment of the parts when welded. The copper jaws are water cooled in all of these machines.

Fig. 3 shows a universal welding machine which welds solid iron or steel up to and including ¾-inch diameter. The

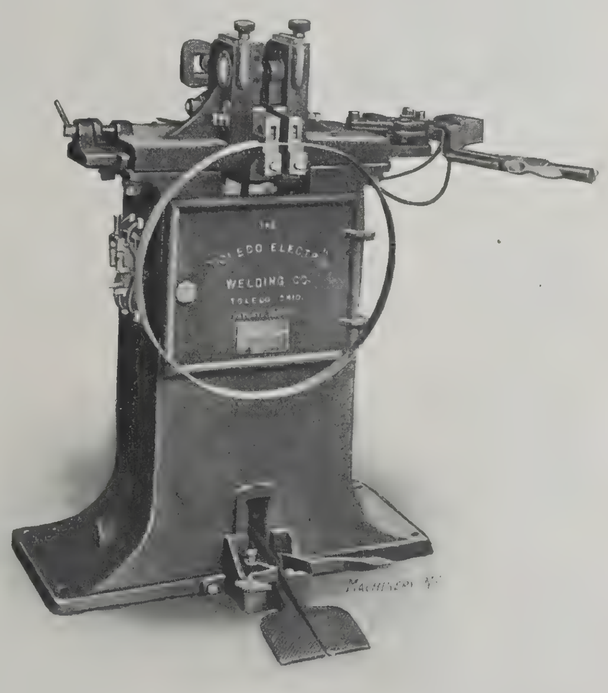


Fig. 3. Universal Welding Machine for Steel up to ¾-inch Diameter

clamping jaws are here actuated by foot treadles, and the current is turned on or off by means of a switch mounted on the lever handle shown at the right-hand end of the machine.

These welding machines are, of course, adapted to work done in quantities and are not intended for the average repair man, who has only a few pieces to weld per day. When work is done in quantities, however, the cost per weld is very small. The accompanying table gives a general idea of the time required for making a weld and the cost per

1,000 welds if the current cost is, say, 4 cents per kilo-watt hour. If the cost of current is more or less than this, the total cost will, of course, be accordingly greater or less. Figs. 4 and 5 show some examples of work which has been electrically welded on the machines shown. These illustrations also give an idea of the variety of work that can be done on these machines. On some pieces part of the metal at the weld has been cut away to the center in order to show the internal structure of the metal at the place where the weld is made.

The underlying principle of the electric welding machine is simple and is based on the fact that a poor conductor of electricity offers so much resistance to the flow of the current that heat is produced, the degree of heat depending on the amount of current and the resistance of the conductor. The process of electric welding is especially applicable to butt welding of metals having practically the same cross-section at the weld. The temperature produced by the current can be maintained at any point desired for any length of time, and any degree of heat may be obtained up to the melting point of the metal. The heat can be increased and decreased at the will of the operator by means of turning on or cutting off the current by the switch on the machine.

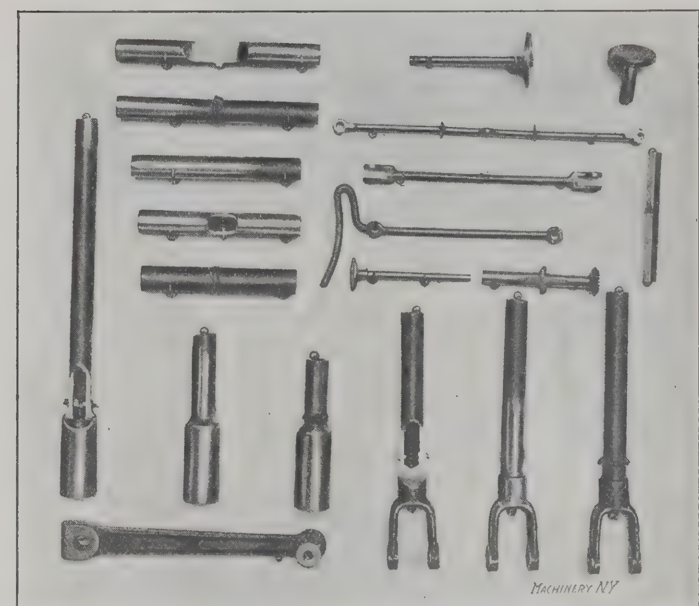


Fig. 4. Examples of Work Welded Electrically

An advantage of the electric welding process is that there is none of the disagreeable glare or blinding effect which takes place either in the arc welding process or the oxy-acetylene process of welding. No goggles or smoked glasses are, therefore, needed. No flux is required in making an ordinary weld.

For electric welding an alternating current is necessary. The current as supplied from a dynamo in the plant or from a central power station is transformed so that it has a pressure of from 4 to 5 volts, there being then absolutely no danger for the operator. The copper clamping jaws of the electric welding machine are similar to a pair of movable

TIME REQUIRED FOR MAKING WELD, AND COST OF 1000 WELDS

Diam. Round Iron or Steel, Inches	Seconds required to Make a Weld	Cost of 1000 Welds at 4 cents per Kw.-hour	Diam. Round Iron or Steel, Inches	Seconds required to Make a Weld	Cost of 1000 Welds at 4 cents per Kw.-hour
$\frac{1}{4}$	3	\$0.28	$\frac{5}{8}$	10	\$1.32
$\frac{3}{8}$	5	0.52	$\frac{3}{4}$	12	2.00
$\frac{1}{2}$	7	0.88	1	20	6.00

vise jaws, and form the terminals of the secondary current of a special transformer located in the welding machine.

When two pieces of iron are to be welded they are clamped between the vise jaws, the ends of the metal to be worked touching each other. The current is then turned on and when the metal reaches a white heat and is in a partially molten state, the ends of the metal are forced together by means of a lever, thus producing a perfect weld. A projection or fin is raised where the ends come together, but this may be ground off or removed by any other suitable means. A weld

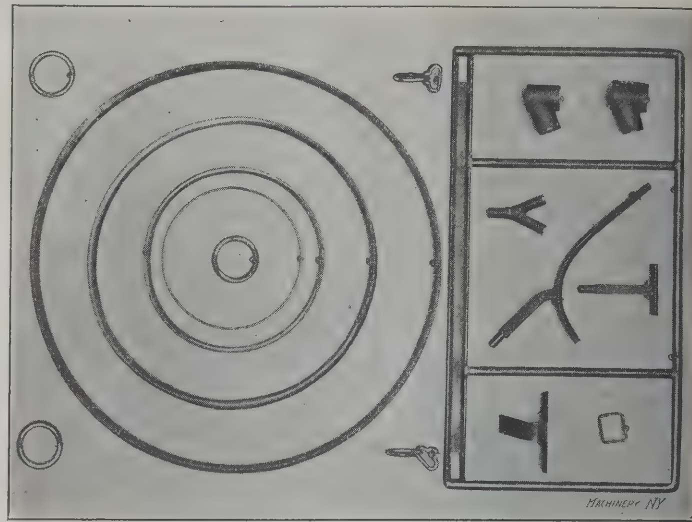


Fig. 5. Other Examples of Electric Welding

properly made in this manner is practically as strong at the welded point as at any other place.

NEW MODEL "STAR" LATHE

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has re-designed its line of 9- and 11-inch "Star" lathes. The accompanying illustration, Fig. 2, shows the lathe having 11-inch swing with a 5-foot bed, known as the No. 30H Star lathe. The following description of the improvements in this lathe also applies to the 9-inch size.

The bed of the machine is mounted on an oil pan as shown. In the head, guards have been provided for the back-gears, and the main spindle, which is made of 60 to 65 point carbon steel, revolves in large ring oiling bearings. The spindle nose is threaded only part of the way, and the remainder is ground cylindrical so as to insure accurate fit for chucks and face-plates. The tail-stock has been made heavier to insure greater strength, and has a longer bearing on the bed; it is provided with side adjustment and an oil-well. The carriage has been made stronger and is provided with T-slots for fastening the tool-posts. The cross-feed screw and the ways have

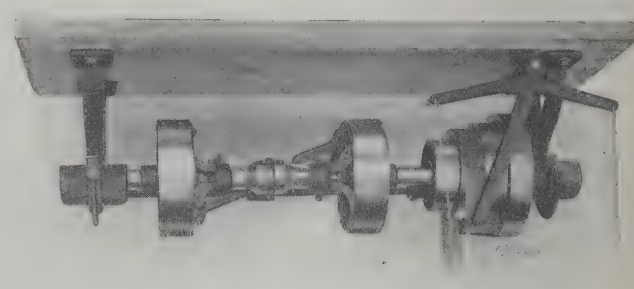


Fig. 1. Counter-shaft for the "Star" Lathe

been carefully protected from chips and dirt by a guard reaching the full length of the slide. The cross-feed screw is provided with a micrometer collar graduated to read in thousandths of an inch, and secured by a friction spring. Even when the machine is not originally provided with a taper attachment, the carriage is so designed that a taper attachment can be applied to the lathe at any time. The plain and compound rest easily interchange, and a binding device has been introduced which facilitates quick changes and rigidly binds the rest to the cross-slide. Graduations up to 180 degrees are provided for setting the compound rest.

The automatic cross and longitudinal feeds are actuated by a friction clutch and driven from the head spindle through gearing and the splined lead-screw, as usual. The range for thread cutting is very wide, it being possible to cut all standard threads from 3 to 72 per inch, including 11½ and 27. The lathe is also furnished for cutting metric threads, either by using proper translating gears with the regular lead-

screw or by using a lead-screw having threads cut with metric pitch.

The change gears have rounded edges so as to avoid injuring the hands when handled. The change gear yoke has an improved intermediate stud which is adjustable from the outer end. All the adjusting screws are provided with uniform size heads, fitting the same wrench as is used for the tool-post screw. Patented split spring washers hold the change gears in place, making convenient and rapid changing of the gears possible.

A full line of regular attachments may be used with this machine including taper attachment, draw-in chucks and collets, automatic draw-in chuck and rod feed, milling and gear cutting attachments, automatic turret on the bed, carriage turret, double tool block, and stop for the carriage. These attachments can be furnished and applied to the machine at any time without special fitting.

Fig. 1 illustrates a new counter-shaft furnished with the machine which is provided with improved friction clutch pulleys with large friction surfaces. In this counter-shaft the wear on the friction parts when the pulley is running idle, has been eliminated, and the usual counter-shaft troubles are, therefore, renduced to a minimum. The belt-shifter for the cone pulley shown in place on the counter-shaft operates quickly and will be found very convenient especially with high ceilings. The hangers are provided with large ring-oiling shaft bearings and are adjustable for alignment. The advantages of these features will undoubtedly be appreciated by the lathe operator.

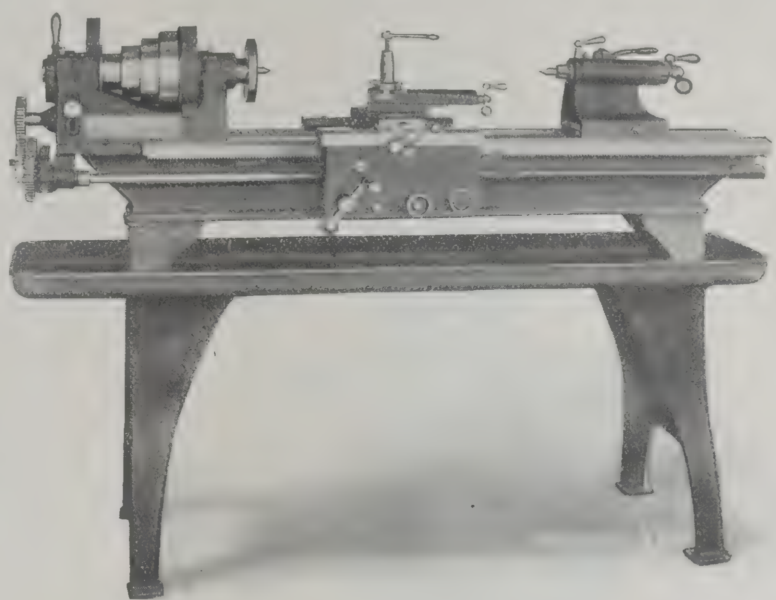
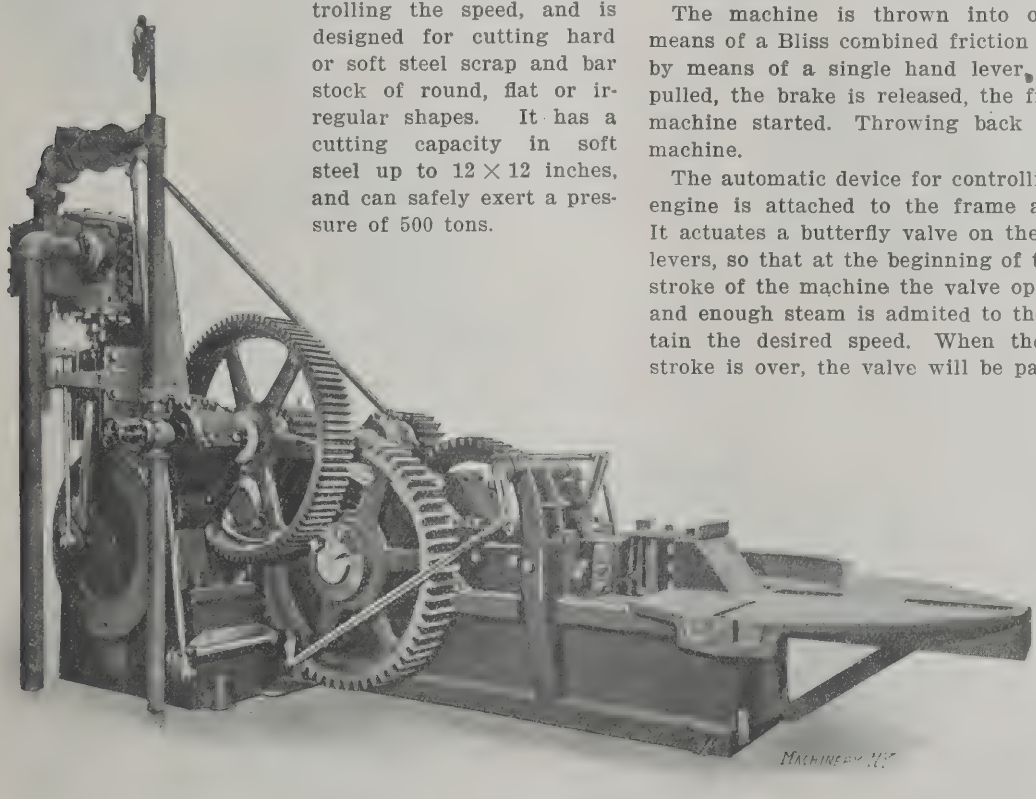


Fig. 2. New Model 11-inch "Star" Lathe, built by the Seneca Falls Mfg. Co., Seneca Falls, N. Y.

BLISS HORIZONTAL SHEARING MACHINE

The accompanying illustration shows a special horizontal shearing machine built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. The machine is driven by an independent steam engine, provided with an automatic device for controlling the speed, and is designed for cutting hard or soft steel scrap and bar stock of round, flat or irregular shapes. It has a cutting capacity in soft steel up to 12 × 12 inches, and can safely exert a pressure of 500 tons.



Bliss Heavy Horizontal Shearing Machine

The slide carrying the cutting knife is designed rather long for the purpose of providing proper guidance. The socket and pin for the pitman end are near the middle of the slide; in this way the downward pressure of the pitman is utilized for minimizing any lifting tendency due to the shear of the knives. The slide is held in position and guided by beveled gibs, firmly bolted both horizontally and vertically. These gibs are designed with a view of making provision for taking up the wear. The stroke of the slide is 4½ inches, which allows the moving knife to safely clear the bar or piece when it is fed in to be cut. The pitman is of cast iron, and the frame, slide and gearing are steel castings. The crank-shaft is made of 50-point carbon open-hearth steel and is 10 inches in diameter in the bearings; the eccentric portion, which serves as a crank, is 14½ inches in diameter. The shaft is driven from both ends, there being a main driving gear on each side of the press. This arrangement tends to reduce the stresses, and makes possible a more rigid and compact machine.

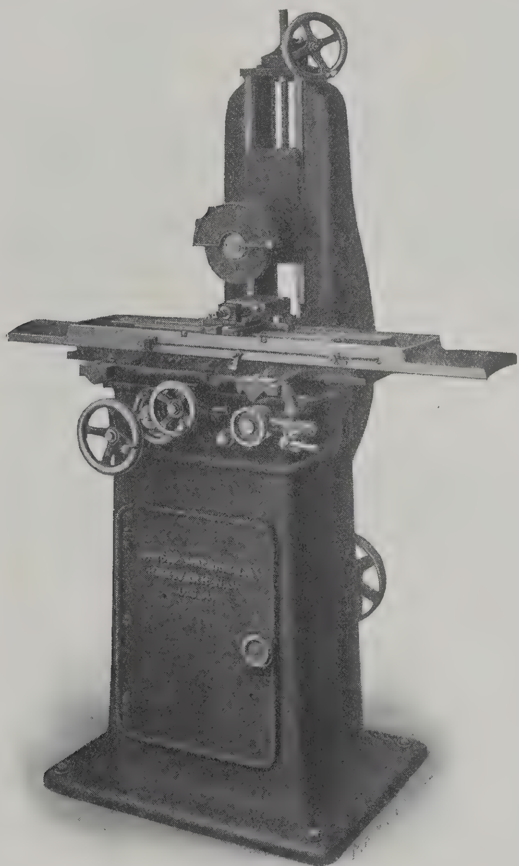
The machine is thrown into operation and stopped by means of a Bliss combined friction clutch and brake operated by means of a single hand lever. When the hand lever is pulled, the brake is released, the friction thrown in, and the machine started. Throwing back the hand lever stops the machine.

The automatic device for controlling the speed of the steam engine is attached to the frame and slide of the machine. It actuates a butterfly valve on the engine through rods and levers, so that at the beginning of the working portion of the stroke of the machine the valve opens wider than previously, and enough steam is admited to the engine cylinder to maintain the desired speed. When the working portion of the stroke is over, the valve will be partly closed, thereby reducing the amount of steam admitted to the engine, and thus preventing excessive speed. This device takes the place of the usual engine governor.

The cylinder of the steam engine is 12 inches in diameter and the stroke is 14 inches, the speed of the engine being from 200 to 250 revolutions per minute. All the gearing is machine cut, and it has a ratio of 17 to 1, which gives a speed of from 12 to 15 strokes per minute to the slide of the machine. With a steam pressure of 80 pounds, the engine will deliver from 70 to 90 H. P. at the speeds mentioned above. The total weight of the machine, including the engine, is approximately 65,000 pounds.

BINSSE SURFACE GRINDING MACHINE

An improved design of surface grinding machine, as shown in the accompanying illustration, has been brought out by the Binsse Machine Co., Newark, N. J. The most important improvements of the design are the added rigidity and the provisions for taking up wear and preserving the alignment—



Surface Grinding Machine built by the Binsse Machine Co., Newark, N. J.

the most important points in securing long life in grinding machinery. The working parts and the feed mechanism have also been efficiently protected from dirt and chips by ample covers and guards, and the arrangement of hand-wheels and levers has been taken care of in such a manner that the greatest possible ease in the manipulation of the machine is assured.

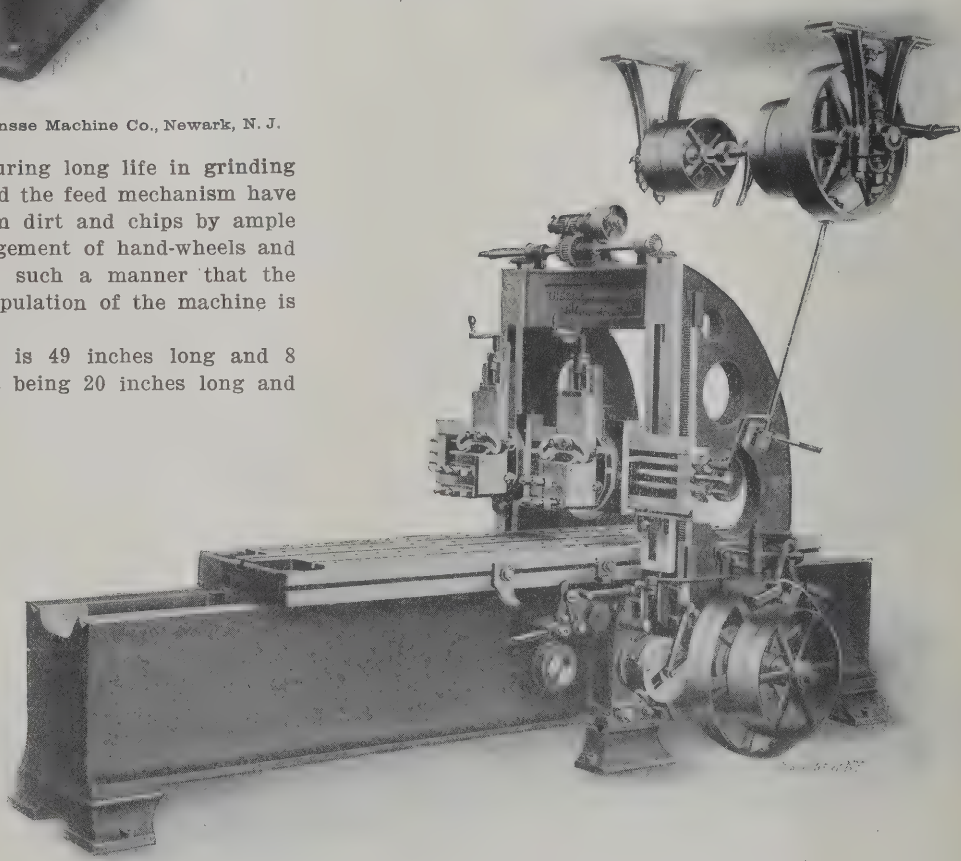
The work-table of the machine is 49 inches long and 8 inches wide, the working surfaces being 20 inches long and 6 inches wide with three slots ½ inch in width. The largest piece of work which can be ground on the machine, using a 7-inch diameter wheel, is 20 inches long, 6 inches wide and 10 inches high. The table is provided with automatic motion in the longitudinal direction, and an automatic cross feed. The length of the stroke is regulated by dogs in the usual manner. The reversing lever can be turned down so it will clear the dogs, thus enabling the table to run past the reversing position, if required, without changing the adjustment. A hand-operated movement for the table is also provided which enables the operator to move the table by hand without changing the automatic feed. The automatic cross-feed movement of the table may be worked in either direction, and it can be stopped automatically when the cut has passed over the work.

The spindle is made of tool steel and is hardened, ground and lapped, and runs in bronze boxes provided with adjustment for taking up all lost motion. The end of the spindle is tapered to receive the wheel flanges. The vertical movement of the spindle is controlled by a hand-wheel at the top of the machine, as shown, which is provided with a graduated dial reading to one-half thousandths of an inch. The shortest distance from the spindle center to the table is 3½ inches and the maximum distance 13½ inches. The maximum size wheel that can be used is 7-inch diameter by ½-inch face.

The machine is equipped with a 7-inch emery wheel, ½-inch face, 1¼-inch hole, with one pair of wheel flanges; a complete separate counter-shaft with tight and loose pulleys, 8 inches in diameter for a 3-inch belt; wrenches and spanners; and flanged vise with hardened jaws, 4⅛ inches long, 1 1/16 inch deep, opening to 2 inches. The counter-shaft should run at a speed of 360 revolutions per minute. The net weight of the machine is 1,500 pounds, and the floor space 6 feet by 3 feet.

CINCINNATI TWO-SPEED PLANER DRIVE

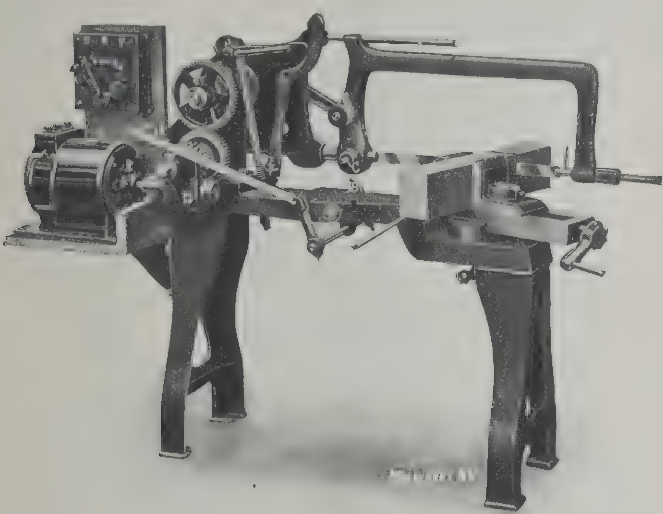
The accompanying illustration shows a planer provided with a two-speed drive brought out by the Cincinnati Planer Co., Cincinnati, O. By means of this drive two cutting speeds for the table are obtainable with a constant return speed. Either of the two cutting speeds can be obtained instantly, and change from the one speed to the other can be made while the machine is running. The speed change is accomplished by the arrangement of the pulleys in the counter-shaft, the drive consisting of two sets of pulleys, one pulley in each set being keyed to the shaft and the other pulley running loose. By operating the lever shown at the side of the housing, either speed required is obtained, the high speed by moving the belt to the right and the low speed by moving the belt to the left. The return belt remains in one position, giving a constant return speed to the table, as mentioned. The simplicity of construction and ease with which the device can be manipulated, makes it very useful for the planer drive; and it can be applied advantageously to all planers from 22 inches to 36 inches, inclusive.



Cincinnati Planer Co.'s Two-speed Planer Drive with Constant Return Speed

ROBERTSON MOTOR-DRIVEN HACK-SAW

The accompanying illustration shows a motor-driven hack-saw built by the Robertson Drill & Tool Co., Department 5, Buffalo, N. Y. The machine shown is known as the No. 3 saw, but all the sizes of the company's saws may be motor-driven by using the same attachment as applied to the present machine. The motor is mounted on a bracket secured to the rear leg of the frame of the machine and provision is made on the same bracket for mounting the rheostat or starting box. The machine is provided with an automatic stop arrangement working through the levers *A* and *B* and actuated by the pin *C*. Lever *A*, shown disconnected in the engraving, connects the switch handle with the cutting mechanism, and when the cut is completed, pin *C* will trip lever *B*, thereby throwing the switch and stopping the machine by cutting off the current.



Robertson Motor-driven Hack-saw

The machine is driven from the motor through a worm and worm-gear, the worm being placed on the motor shaft inside of the housing *D* and the worm-gear on a shaft on which a spur gear is also mounted from which in turn the power is delivered to the reciprocating saw mechanism. The worm and worm-wheel run in oil.

The machine can be conveniently mounted on a platform or truck and taken to any place inside or outside of the shops, where beams, bars or other steel parts have to be cut. It thus serves the purpose of a portable machine, and the only thing necessary is that electric power be available, so that the machine can be easily connected by wiring at any place where it is to be used.

STARRETT'S MACHINISTS' AND TOOL-MAKERS' TOOLS

A number of new machinists' and tool-makers' tools have been recently brought out by the L. S. Starrett Co., Athol, Mass. Fig. 1 shows a taper gage in which the thin leaves

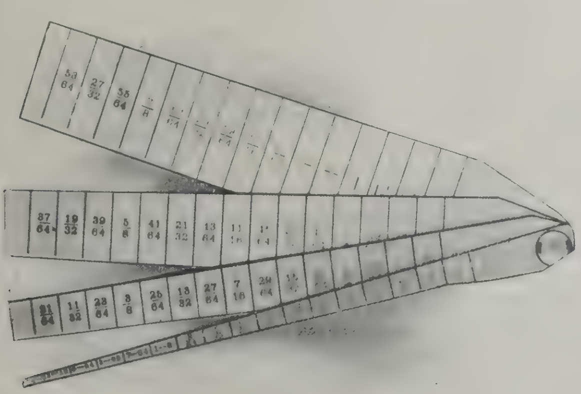


Fig. 1. Starrett Taper Gage

are tapering, the widths varying by 1/64 inch for every quarter inch of the length of the gages. The gages are graduated by lines ¼ inch apart, and on each gage is stamped the width at each division, the graduations reading by 64ths from 1/16 up to 1 1/16. The gage is designed for brass and steel tube manufacturers, for inside measurements, and is also convenient for tool-makers and machinists when measuring the width of slots and the size of holes, as well as for setting calipers to size within its capacity.

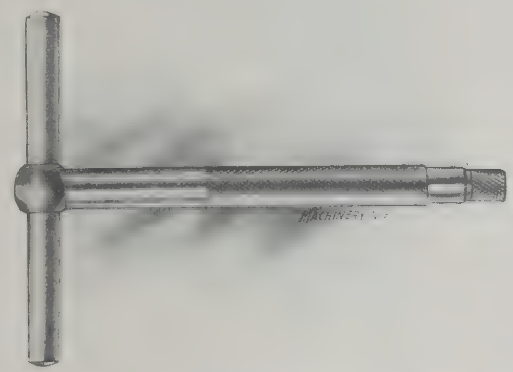


Fig. 2. Telescoping Gage used in conjunction with Outside Micrometer for Inside Measurements

Fig. 2 shows a telescoping inside gage by means of which the exact size of holes or slots can be measured by outside micrometers, so that various classes of fits, varying in thousandths of an inch or less, can be made and measured without resorting to inside micrometers. The instrument is used in the following manner: The telescoping head is compressed and the plunger locked by a slight turn of the knurled screw in the end of the handle. The head is then inserted inside of the hole to be measured, the lock is released, and the plunger allowed to expand to fit the hole. Then the plunger is again locked by a slight turn of the screw. The instrument is withdrawn and is calipered over the ends of the head with a micrometer, thus obtaining the exact size of the hole. The ends of the telescoping head are hardened and are made to a radius equal to that of the smallest hole the instrument will enter. The gages are made in five sizes, the total range of the complete set being made to enter holes from ½ inch to 6 inches.

In Fig. 3 are shown a number of tool-makers' buttons with screws and washers for jig work. The buttons are hardened

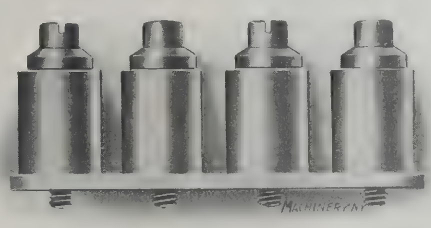


Fig. 3. Tool-makers' Buttons with Screw and Washers for Jig Work

and ground to exact standard size, the diameter being 0.400 and the length ½ inch. The use of these buttons in jig making is well-known to tool-makers, and constitutes one of the most accurate methods for laying out holes with accurate center distances in jigs. These buttons are furnished in sets of four screwed into a small plate, which makes a convenient holder for them when not in use.

MAYMONT SELF-OILING LOOSE PULLEY

The accompanying half-tone illustrations, Figs. 1 and 2, and the line engraving Fig. 3, show a new design of loose pulley brought out by the McMaster-Carr Supply Co., 176 Lake St., Chicago, Ill., and known as the Maymont self-oiling loose pulley.

As shown by the illustrations, the pulley is made in halves and bolted together, and provided with an oiling collar between the two halves. Fig. 1 shows the outside of the enlarged hub which encloses an oil reservoir. This reservoir is plainly shown in Fig. 2, where the two halves of the pulley are shown before final assembling. The two halves are bolted together with a thin oil-proof gasket between, to prevent leakage of oil. The oil distributing collar is fixed to the shaft by two set-screws, and therefore also serves the purpose of shaft collar, so that no outside collar is needed

Fig. 3 shows the construction of the pulley. *A* is the collar with its two set-screws. All the rest of the pulley is free to rotate on the shaft. The collar has two curved wings or lips *B*, extending outward so that they nearly touch the inside walls of the oil reservoir. Close inside of these wings

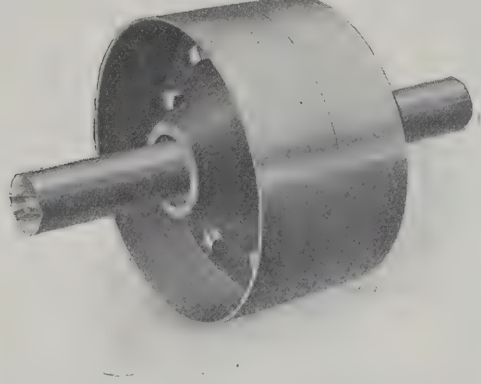


Fig. 1. The Maymont Self-oiling Loose Pulley

are inclined drilled holes *C* passing through the body of the collar and leading to the shaft at each side. Cored into the hubs at the outer ends are recesses *D* and *E*, the former closed and the latter open, as shown. These recesses are connected with the central reservoir by four drilled channels *F*. As the pulley rotates, these holes at their reservoir ends pass close to the wings of the fixed collar.

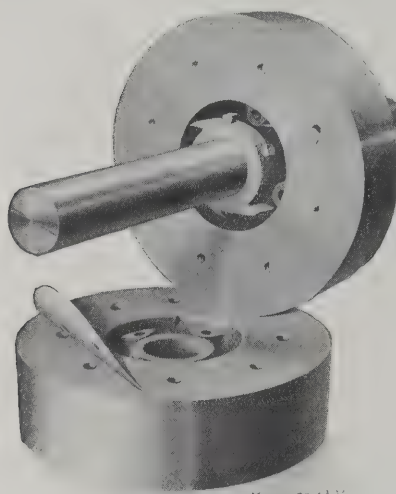


Fig. 2. View of Pulley in Halves, showing Oil Reservoir and Collar

The operation of this device is as follows: As the pulley rotates, the oil in the reservoir is carried up by the wings *B* of the collar, and forced into the holes *C* leading to the shaft, where the oil passes directly onto the surface between the hub halves and the shaft. Working along either way of the shaft, the oil reaches the end recesses *D* and *E*, where the centrifugal force carries it outward to the ports *F* and through them back into the reservoir. As the oil returns through the channels *F*, the wings *B* collect it and again force it into the holes *C*; thus continuous circulation of oil is automatically maintained.

The joint between the two halves of the pulley is made tight by a thin oil-proof gasket as shown in Fig. 2. The centrifugal force prevents oil from leaking out along the shaft when the pulley is in motion, and when it stops the

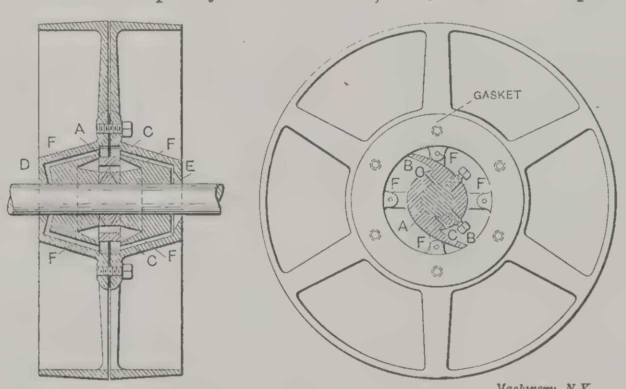


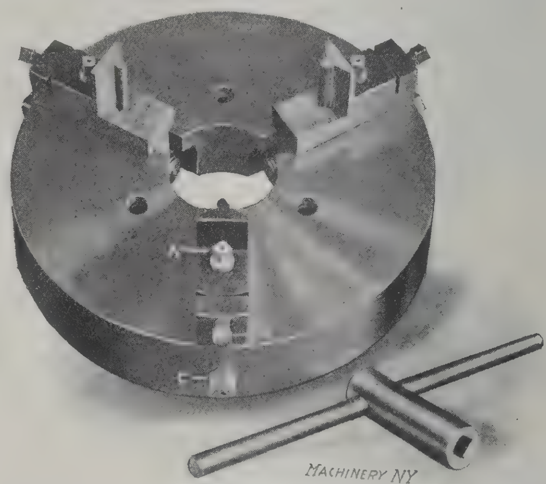
Fig. 3. Section of Self-oiling Pulley, showing Construction

oil in the channels *F* above the shaft will drain to the recesses *D* and *E*, and from there down around the shaft to the bottom of the reservoir. The oil is fed in with the pulley in motion by feeding it in at the open end *E* of the pulley. As there is practically no loss of oil, an addition of a small amount of oil once a month usually maintains the supply.

With slight alterations the construction can be changed to suit vertical and inclined shafts. The pulley is made regularly in sizes from 6 to 30 inches diameter, and with width of face to suit conditions. Special sizes of pulleys are made to order.

SKINNER CHUCK FOR HOLDING AUTOMOBILE GEARS

The accompanying illustration shows one size of a line of special three-jaw universal chucks designed especially for holding automobile gears on the pitch line, and made by the Skinner Chuck Co., 94 No. Stanley St., New Britain, Conn. This line of chucks is especially adapted for use on grinding machines when grinding the holes of hardened gears true with their pitch circle. The chuck shown in the illustration is known as the 12-inch size and is set for a 6-pitch gear with a number of teeth which can be evenly divided by 3. Within



Skinner 12-inch Chuck for Holding Gears true with the Pitch Circle

its range it will hold the gear true at the pitch line at three points. When the number of teeth in the gears is not evenly divisible by 3, it is necessary to loosen the binding screws *A* on two jaws, leaving the third jaw stationary. The gear is then placed in the chuck, and the jaws are adjusted by means of the pinion screws *C*, each jaw being thus permitted to find its own place. The binding screws are then tightened enough to hold the top of the jaws in this position. The gear is removed and each jaw is set an equal distance from the center by means of the independent adjusting screws *B*, a test indicator being used for this purpose. Then the binding screws are firmly tightened and the chuck is ready for operation. Gears of any pitch can be held in these chucks by using interchangeable top jaws with rounded ends of suitable size for the required pitch.

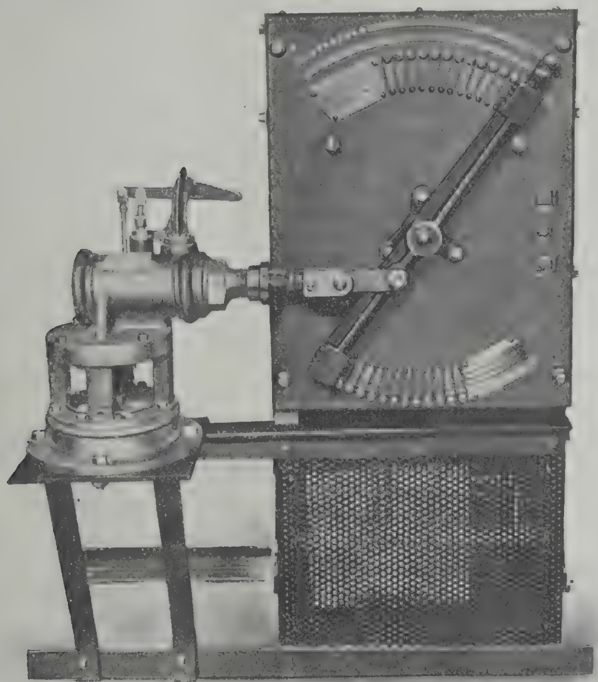
CUTLER-HAMMER PRESSURE-CONTROLLED SPEED REGULATOR

The accompanying illustration shows an interesting speed regulator built by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., and intended for use in connection with electric motors operating the blower of a mechanical stoker, a boiler feed pump, a gas pressure blower, etc. It automatically regulates the speed of the motor to maintain the operating pressure practically constant.

The controlling equipment for use in connection with a direct current motor consists of a standard hand-operated starting rheostat (provided with no-voltage release) and a special speed regulator designed to vary the speed of the motor in accordance with the variations of pressure of the boiler system served by the stoker. The speed regulating part of the equipment may be designed to reduce the speed of the motor below its normal rated speed by inserting resistance in the armature circuit, or to raise the motor speed above normal by field weakening, or by a combination of these two methods.

A direct current blower regulator designed for armature and shunt field regulation is shown in the accompanying en-

graving. Another regulator is also designed for armature regulation only. The regulator consists of a slate panel mounted on the front of an angle iron cage, the panel carrying the contact segments over which a double-ended lever moves. The cage contains the necessary regulating resistance. The lever is actuated by the piston of a hydraulic cylinder, the admission and exhaust port valves of which are in turn controlled by the movement of a pressure regulator diaphragm, one side of which is subjected to the boiler



Cutler-Hammer Pressure-controlled Speed Regulator arranged for Armature and Shunt Field Regulation

pressure. The normal boiler pressure on the under side of the diaphragm is balanced by a weighted lever bearing on the top of the diaphragm in such a manner that the lever will rise or fall as the boiler pressure rises above or falls below the normal pressure for which the lever is counter-balanced. This up and down movement of the lever operates a pilot valve controlling the admission of water to the hydraulic cylinder, and due to the variations in pressure, the piston of the cylinder is moved back and forth, and in turn actuates the double-ended lever, the ends of which move over the contact segments on the slate.

The operation of cutting the resistance in and out of the circuit is not a continuous operation but proceeds step by step with pauses between each movement of the contact lever. This is accomplished by the bell crank connection shown above the cylinder. The lower end of this bell crank is connected to the piston rod of the cylinder and the upper end to the floating lever. Any upward movement of the weight lever results in an upward movement of the floating lever, admitting water to the right-hand end of the cylinder and forcing the piston to move inwardly (to the left), while any downward movement of the weight admits water at the left-hand end of the cylinder and forces the piston rod out (to the right). As soon as the piston begins to move, however, it exerts through the bell crank connection a pressure on the floating lever exactly contrary to the movement produced by the weight lever; that is, if under the influence of increasing steam pressure the weight lever moves up, the pilot valve stem and floating lever will also move up, and the piston rod of the cylinder will start to move to the left. This movement of the piston, however, is presently checked by the operation of the bell crank attached to it which pulls down on the floating lever, depresses the pilot valve stem, and shuts off the water pressure, stopping the movement of the piston and the lever on the slate actuated by it. Thus the lever proceeds step by step with a pause after each movement, resulting in a gradual cutting out of resistance and increase in motor speed.

The cylinder has been assumed to be hydraulically operated in the description above, but if water pressure is not available the same results are accomplished by connecting the inlet of the cylinder to a compressed air tank; the pressure, however, whether air or water, should not be less than 25 pounds per square inch. The system, as described, applies to direct current motors, but a regulator can also be furnished for alternating current motors, the operation being similar to the one described.

MULTIPLE TOOL-HOLDER FOR THE LATHE

A multiple tool-holder which was invented by Mr. F. J. Brewer and placed on the market by the Multiple Tool-Holder Co., 3197 West 48th St., Cleveland, O., is shown in the accompanying illustrations. As shown in Fig. 2, this tool-holder can be used for holding four tools at a time, and it is, in fact, a small temporary turret which can be applied to any engine lathe. Provision is made for indexing the upper part of the holder to different positions, so that the tool is particularly useful when a number of similar pieces are to be made and but few operations are necessary. This holder can also be used with equal advantage for chucking work, boring and turning. It is provided with a T-shaped bottom piece which fits in the slot where the usual tool-post is attached to the cross-slide of the lathe. This bottom piece, *B*, Fig. 1, is held in place by two set-screws *C* so that it will not shift when the top part of the holder is loosened for the purpose of indexing it. Indexing pins *D* for accurately locating the upper or turret part of the holder, are provided. These pins, which operate in threaded bushings screwed into the bottom piece, are pressed against the plate *E* by springs *F*, so that when the turret is turned it is easy to determine when the pins are in alignment with the holes in plate *E*. This plate has eight holes, and it is screwed and doweled to the bottom of the tool-holder proper. All indexing parts are made of hardened

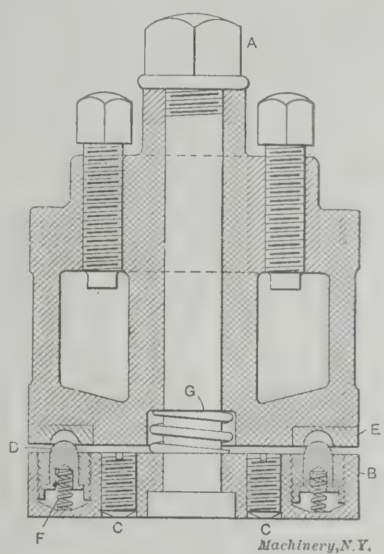


Fig. 1. Sectional View of the Brewer Multiple Tool-holder

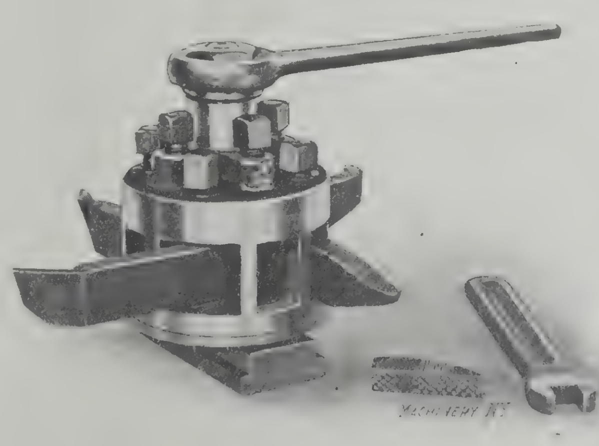


Fig. 2. Brewer Multiple Tool-holder for the Engine Lathe

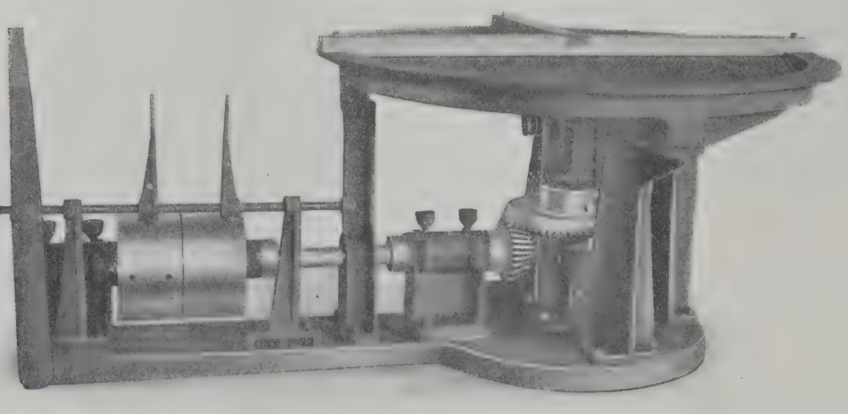
tool steel and the holder proper is a steel casting. The tools are adjusted vertically by the ordinary shoe or wedge, one of which is shown in Fig. 2. Each tool is held in place by two set-screws, and it can be clamped in either of two positions at right angles to each other. When the holder and the tools are properly adjusted, it is securely locked in position by turning the center clamping nut *A*. One-half a revolution of this nut releases the holder so that it may be indexed. When this nut is released the turret part of the holder is lifted by

a central spring *G*. As this tool-holder practically transforms an engine lathe temporarily into a turret lathe for work where only a few operations are required, it will undoubtedly prove a useful tool in any machine shop, particularly as it can be very quickly attached and detached, and in no way interferes with the usefulness of the lathe for ordinary straight turning work.

BESLY HORIZONTAL DISK GRINDER

The accompanying illustration shows a new 48-inch horizontal disk grinder brought out by the Charles H. Besly Co., 15 So. Clinton St., Chicago, Ill. This machine is designed for grinding large surfaces such as fire doors, door jams of furnaces, stove doors, and large gear case covers for automobiles.

The method by which the machine is driven is clearly shown in the illustration. The belt used for driving is 8 inches wide and runs on a 12-inch diameter pulley from which the power is transmitted to the grinding wheel spindle by means of a 2-inch horizontal shaft and bevel gearing. The gears have planed teeth, and all gears and pulleys are keyed and held in place by set-screws directly on the keys. The vertical spindle, to which the large bevel gear is attached, is 3 inches in diameter at the bearings and 6 inches in diameter at the wheel collar, and is provided with a pilot 2 inches in diameter for holding and centering the disk wheel. The thrust is taken by two hardened tool steel blocks, one of which is secured to the lower end of the spindle and rotates



Besly No. 19, Forty-eight inch Horizontal Disk Grinder

with it, while the other is secured to the bed plate. Proper attention has been given to the lubrication of this thrust bearing.

The spindle and driving-shaft bearings are 9 inches long and are of the split type, babbitted and reamed. The disk wheel is 48 inches in diameter and provided with ribs radiating from the hub to the outer rim. The thickness at the hub is 2½ inches, between the ribs ¾ inch, and at the rim 1½ inch. A guard ring is provided around the disk wheel, projecting ¾ inch above the face of the wheel. This prevents the work from flying off the disk wheel while being ground. The top surface of the guard ring is machined true with the face of the disk wheel, so that bars, jigs, etc., for holding the work to be ground can be secured to it. The speed of the disk wheel is 400 revolutions per minute, and the bevel gearing being in the ratio of 1 to 2, the driving shaft should run at 800 revolutions per minute. The machine can be driven either direct from the line-shaft or from a counter-shaft as required. The operating space for the machine is 8 by 10 feet, and the height over all 32 inches. The net weight of the machine complete is 2,400 pounds.

MOTOR-DRIVEN SENSITIVE DRILL

In the June, 1908, issue of MACHINERY, a sensitive drill built by the Rockford Machine & Shuttle Co., of Rockford, Ill., was described. An improvement on this machine was illustrated in the department of New Machinery and Tools in the March, 1909, issue of MACHINERY. The improvement related particularly to the drive, the general arrangement of the machine being unchanged. The company has now brought out a motor-driven machine of the same general design as the one described in the previous issues. The driving cone, however, is eliminated, and a bracket is provided instead on the lower part of the column on which is placed the motor and starting box. The bracket for the motor is mounted on a slide which is vertically moved by means of an adjusting screw so that the tension on the driving belt can be varied. This movement permits an adjustment of 3 inches, which is sufficient to take care of the stretch of the belt for a long time without requiring that the belt itself be shortened. In all other details the machine is the same as that which has previously been described in MACHINERY.

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NEW MACHINERY AND TOOLS NOTES

ANGLE BENDER: Estep & Dolan, Sandwich, Ill. This machine has a capacity for bending round or square stock cold, up to 1¼ inch in size, to a right angle, and it can be used for bending flat stock up to 4 by ½ inch.

IMPROVED BALL BEARING UNIVERSAL JOINT: B. Frank Teal, Glenside, Pa. In this device the journal friction on the trunnions has been largely eliminated by using a ball bearing trunnion with automatic lubrication. The bearings are dust-proof. The weight and dimensions are no greater than of the ordinary type of universal joints.

HEIGHT GAGE: Louis Mastrangal, 35 Spring St., West Hoboken, N. J. This instrument is designed to provide means whereby the distance between a stationary surface and a given point outside of it may be accurately determined. It consists of a base carrying an upright, which in turn carries the gage mechanism proper.

"HIGHPOWER" TWISTED DRILL: Pratt & Whitney Co., Hartford, Conn. This is a flat twisted drill with a twisted taper shank and is practically the same as the Hackett twisted drill shown in the October, 1908, issue of MACHINERY. Another convolution has been added to the shank, however, to increase the holding power in the socket.

LINE OF POPPET DROP HAMMERS: Miner & Peck Mfg. Co., New Haven, Conn. These hammers are adapted particularly for silverware, jewelry and similar light stamping work, and are used as plain drops, controlled by the foot or hand, and operated by the maker's lifting pulley, or automatic lifter. The four-poppet drop is made in five sizes of 50, 100, 150, 200 and 300 pounds, respectively, and the six-poppet in five sizes of 300, 350, 500, 600 and 800, respectively.

GASOLINE HEATING TORCH: Volcano Torch & Mfg. Co., Erie, Pa. This torch is intended for making or releasing shrinking fits of various descriptions, extracting broken taps and drills, brazing, straightening shafts and similar work between lathe centers, annealing, hardening and tempering tools, and for repair work in general. Pieces three inches in diameter can be heated to a red heat in from ten to fifteen minutes. The torch can also be used for illuminating by changing the burner plug.

UNIVERSAL PLATE, BAR AND ANGLE SHEAR: Covington Machine Co., Covington, Va. This machine is adapted both for boiler-makers and structural shops. The location of the angle shears permits right or left angles of even or uneven legs to be cut to any angle up to 45 degrees. The clutch mechanism is positive and stops the knives at the highest point of the stroke. A table and gages are provided for the double angle shear for cutting different angles. Bars may be cut in either the angle or plate shear.

GEAR TOOTH GRINDER: G. W. Baker Machine Co., Wilmington, Del. This machine is intended for grinding the teeth of cast spur and bevel gears, as well as of racks. The grinding head carries a wheel of a shape to suit the gear tooth to be ground. The machine is adapted for spur gears up to 36 inches in diameter, and an attachment is furnished for holding bevel gears at any required angle while being ground. The work is indexed by use of a tooth rest engaging with one tooth in the gear while another tooth is being ground.

HOB GRINDING ATTACHMENT: Brown & Sharpe Mfg. Co., Providence, R. I. This attachment, used on the company's No. 13 universal and tool grinding machine, is intended for accurate sharpening of spirally fluted hobs by grinding the faces of the teeth. The mechanism for revolving the hob resembles in design that of the spiral head used on universal milling machines. Hobs with from two to twenty grooves can be ground, index plates being furnished for indexing within these limits.

SCREW DRIVER: Lynn Tool Forging Co., 260 Maple St., Lynn, Mass. This tool consists of a very substantial handle and is provided with blades specially forged and inserted by a locking arrangement so that the screw driver cannot work

loose from the handle, and the annoyance usually met with on this score is eliminated. Three blades of different lengths and widths are provided with each handle. The blades are forged from square stock so that a wrench can be used on the screw driver if necessary.

Sand Blast Nozzle: Walter Macleod & Co., Cincinnati, O. This nozzle largely overcomes the expense and annoyance in connection with the use of sand blast, due to rapid wear of the nozzles. By a special construction a film of air is interposed between the sand and the nozzle, which in an effective manner prevents undue wear. The device works by suction, and the sand reservoir may be placed at any convenient point, as the nozzle will elevate the sand to a point up to 50 feet above the sand tank.

Universal Shear: C. C. Wais Machine Co., Cincinnati, O. This machine is designed particularly for boiler makers and structural iron workers for cutting plates, bars and angles of even and uneven lengths of legs. The changes required and the loss of time incident to cutting angles or plates on an ordinary punching and shearing machine are eliminated. The machine is built in five sizes, the largest adapted for angles 6 x 6 x 1 and 7 x 7 x ¾ inch, and to cut plates ⅞ inch thick. The smallest will take angles 3 x 3 x ½ and 4 x 4 x ⅜ inch, and will cut ¼-inch plates.

Blue-print Washing Machine: Williams, Brown & Earle, Philadelphia, Pa. This machine is intended to accompany the makers' blue-printing machine mentioned in the August issue of Machinery. The machine is attached to a water pipe and takes care of the blue-prints as they come from the printing machine, washing them and passing them over a gas drying arrangement; the prints can then be delivered at the rear either separately or in a continuous roll. In connection with the electric blue-printing machine referred to, four feet of prints can be printed, washed and dried per minute.

Double Crank Press: E. W. Bliss & Co., 5 Adams St., Brooklyn, N. Y. This machine is designed for accurate cutting and punching operations extending over the entire width of large sheets which are fed through the machine from front to back. The safe working capacity of the machine is from 100 tons for operations requiring great rigidity, up to 140 tons for less particular work. The machine can be provided with an automatic feed for sheets from 6 to 10 feet wide and up to 40 inches long. It is driven by a direct connected 10 H. P. motor and makes 18 strokes per minute.

Hydraulic Beam Shear: Watson-Stillman Co., 192 Fulton St., New York City. This machine is designed for cutting I-beams, channels, flat bars, angle irons and other structural shapes, and may be used for cutting round sections in emergencies by removing the regular cutting mechanism. It can also be readily converted into a powerful hydraulic press for general work. The machine is made in two sizes to take beams and sections having the longest dimensions 15 and 24 inches, respectively. It is hydraulically operated. The weight of the smaller size shear is 12,000 pounds, and that of the larger, 16,500 pounds.

Automatic Two-jaw Chuck: Cleveland Chuck Co., 514 Garfield Bldg., Cleveland, O. This chuck is intended as a substitute for the old style box chuck. It is mechanically operated, but its action is similar to that of a pneumatic chuck, while the expense of installing and maintaining an air supply system is eliminated. The gripping action is accomplished by a rocking movement of the jaws, effected by the spreading of the rear ends by the axial movement of a conical collar. One pair of jaws is required for every 1/16 inch difference in diameter of the work, but the device is so designed that the change for different sizes is very quickly made.

Drill Press with Universal Table: Robertson Drill & Tool Co., Department 5, Buffalo, N. Y. This machine, known as the tilting table drill press, is provided with a table which can be swung to any position in the vertical plane. It is operated by worm and worm gear, and graduations up to 90 degrees are provided so that the table can be set accurately to a given angle. After the table has been swung into an angular position it can be turned on its center bearing so as to bring the work to any position under the drill. It can be tilted over to either side of the knee, and clamping bolts are provided to secure it firmly in any position.

Machine for Testing Hardness of Metals: Tinius Olsen & Co., 12th and Buttonwood Sts., Philadelphia, Pa. This machine is designed for use in every-day shop practice for testing the hardness of locomotive tires and other material entering into locomotive construction. The test is made by means of the Brinell method, using a ball which is subjected to a standard pressure for different materials. A dial is provided where the amount of penetration of the ball in the material tested may be read off directly without calculations. To make a test with this machine requires less than a minute, including the time necessary for inserting and removing the test specimen.

Transmission Devices: Carl M. Wheaton, 9 Callender St., Providence, R. I. The devices brought out include a self-oiling bearing in which the oiling device consists of a number of cork balls contained in tubes and held in contact with the shaft by their buoyancy or inclination to float on the oil; a method of hanging shafting in rooms with high ceilings, consisting of brackets holding a pipe which in turn supports the hangers; a clutch pulley where centrifugal action is made use of for throwing out a counter-weight holding the friction surfaces out of contact except when forced into position by the clutch lever; and a loose pulley with special oiling arrangement.

Hydraulic Coping Machine: Watson-Stillman Co., 192 Fulton St., New York City. This machine, designed for trimming structural shapes, small pieces of plate metal, bar iron, etc., is especially intended for use in steel mills, shipbuilding plants, and structural iron, boiler and locomotive shops. It is operated by hydraulic pressure and consists essentially of a heavy steel beam or lever actuated from the rear, and having the forward end fitted with shearing knives. The construction offers a large number of cutting combinations, the change from any one of which can be made in less than a minute's time. The machine is operated by a foot lever. The total weight of the machine is 4,700 pounds.

Testing Machine of 1,200,000 Pounds Capacity: Tinius Olsen & Co., 12th and Buttonwood Sts., Philadelphia, Pa. This testing machine has been designed for the new testing labaratory of the Rensselaer Polytechnic Institute of Troy, N. Y. The method of weighing the load is a departure from all previous methods. The pressure in the main cylinder is transmitted to a diaphragm, which is exactly 1/25 of the area of the main press cylinder. The pressure on the diaphragm is communicated to a lever system terminating in a standard dial vernier screw beam. As the transmission of pressure through the diaphragm is frictionless, the amount of pressure is thus weighed with great accuracy.

Double Seamer for Cans: Charles Leffler & Co., 49 Clymer St., Brooklyn, N. Y. This machine, known as the No. 21 double head automatic square double seamer, will simultaneously double seam the top and bottom to the body of square and irregular cans, such as cocoa cans, powder cans, etc. The machine is entirely automatic and can be operated by one man. All that is required of the operator is to put the cans on and off of the machine and press the treadle. Despite the complicated movements required, the machine works as easily as single end machines, and runs at the same speed. It will take work up to 8 inches wide and 12 inches high. It is possible to double seam more than 10,000 can ends, of certain shapes, per day.

Steam Turbine: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This steam turbine is the outcome of several years of experimenting; as far as possible the weaknesses of other turbines have been avoided, and structural strength is one of the main features of the design. The steam is expanded completely in the nozzles, so that there is no difference in pressure between the buckets in the wheel and the reversing chamber, and consequently no loss from leakage. This makes it possible to run with a very large clearance without the primary losses in efficiency common in most turbines and caused by steam friction and leakage. The turbine is made in types for operating both condensing and non-condensing, and also to run on exhaust steam from reciprocating engines.

Speed Reducer: Foote Bros. Gear & Machine Co., 44 No. Carpenter St., Chicago, Ill. This device is designed for driving machinery running at relatively low speeds from a source of power running at a high speed. The speed reducer known as style D is particularly adapted for high reduction ratios, and will give any reduction of speed up to 60 to 1. These reducers can be furnished in seven sizes, in capacities from 1 to 50 H. P. The reduction of speed is obtained through spur gears, but the design provides for elimination of the usual objections to a spur gear speed reducer in that sufficient central support of the shaft between the high and low speeds is provided. There are no rotating parts in the interior that can get out of balance and cause vibration.

Flame Welding Outfit: Schaap Flame Utilities Corporation, 344 Cumberland St., Brooklyn, N. Y. This apparatus is designed for the purpose of fusion welding cast iron, aluminum and other metals by the heat generated by combustion of the illuminating gas. The special novelty of the device is the torch. A mixture of gas and air under high pressure is sent through the tip in the center of the torch, thus generating the heat for melting the metal to be welded. A mixture of gas and air under low pressure is forced through openings of the torch which surround the central nozzle and this mixture protects the central jet from the outside atmosphere; for this purpose the torch is composed of five tubes, one inside of the other, with a space between each for the low-pressure gas to pass through.

Drilling and Milling Machine: W. B. Knight Machinery Co., 2019-2025 Lucas Ave., St. Louis, Mo. This machine, known as the No. 2 Knight drilling and milling machine, is designed with the object in view of furnishing a machine on which a great variety of both drill press and vertical milling machine work can be done. It is built along the same lines as the original Knight machine, but is intended for much heavier duty. The machine is particularly advantageous to use upon work which requires drilling, boring and milling op-

erations which ought to be done at a single setting of the work. In this way greater accuracy is obtainable, and a considerable saving in time is effected. The table of the machine can be tilted, and is mounted so as to permit of rapid adjustment. This permits some of the operations required to be performed at an angle with some of the other operations.

Improved Pipe Machine: Bignall & Keeler Mfg. Co., Edwardsville, Ill. This machine is designed for cutting off and threading pipe from 2½ to 8 inches inclusive, and has been constructed with a view of eliminating rocking gears and clutches. The speeds are obtained through a gear box and a compound sliding gear on one of the shafts, a speed plate attached to the box showing how to obtain the speeds for the various sizes of pipe. A single driving pulley is used, and the belt speed, consequently, is constant. The die-head is of the "low-down" type, placing the handles and die lever within easy reach of the operator, and is equipped with a special adjusting mechanism, making it very simple to operate. The chucks are of the independent type, each having three jaws, and the jaw slides are graduated and easily set to any required size of pipe. On the rear chuck, the slides are provided with flange grippers in addition to the regular pipe grippers, so as to hold flanged work. The pipe grippers are of hardened steel, are dove-tailed into the ends of the slides, and can be removed and sharpened.

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HEAVY TRAINS ON THE VIRGINIAN RAILWAY

The Virginian Railway, built by the late H. H. Rogers, is probably the most carefully engineered railway in the United States, if not in the world. It was planned with the idea of making a locomotive utilize its maximum hauling capacity from the coal fields in the Alleghanies to Tidewater. It was recently announced that 80 cars of 100,000 pounds capacity each had been hauled from Alleghany summit to Tidewater, the total weight of the cars being 4,310 long tons. This record was soon beaten by a train of ninety cars loaded with 100,000 pounds, drawn by a single Mikado type locomotive. The total weight of the train approximated 7,000 tons. The maximum adverse grade is about 0.2 per cent, compensated. The grades are such that the empty cars can be hauled back to the mines by a single locomotive in trains equivalent in length to the loaded trains. That is, a locomotive that is able to handle ninety cars to Tidewater is able to haul the empty cars back to the mines.

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PERSONAL

Herbert L. Beeler has been appointed advertising manager of the R. K. Le Blond Machine Tool Co., Cincinnati, Ohio.

C. W. Wrenshall, superintendent of the Western Steel Car & Foundry Co., has been made general superintendent of the Pressed Steel Car Co., Pittsburg, Pa.

H. E. Longwell has been appointed consulting engineer with particular jurisdiction over the publicity department of the Westinghouse Machine Co., East Pittsburg, Pa.

W. A. Bole has been appointed assistant manager of the works of the Westinghouse Machine Co., East Pittsburg, Pa., with particular jurisdiction over the Trafford Works.

Otto J. Rantz, formerly in charge of the shop work at the Haverford College, Haverford, Pa., has been appointed superintendent of the Stephens Industrial School, Lancaster, Pa.

John Scott, a contributor to Machinery, recently was promoted to the position of factory inspector of the Tomson Co., Lowell, Mass.

H. L. Mills, president of the American Specialty Co., Chicago, has just returned from an extensive business trip through the East.

Hiram Pruim, for nearly ten years in the employ of the William Hahn Co., Chicago, makers of flexible shafts, has been made superintendent.

J. E. Stark, formerly with the Courier Koeth Mfg. Co., has accepted a position as superintendent of the Western Wire Goods Co., of Buffalo, N. Y.

R. L. D. Mackie, formerly with the Morgan Construction Co., Worcester, Mass., is now manager of the high pressure and pipeage department of the W. J. Scholl Co., Youngstown, Ohio.

W. S. Heger, of the Allis-Chalmers Co., who was formerly assistant to the president, has been placed in charge of the company's interests in southern California, with headquarters at Los Angeles.

Harold O. Rugg, a graduate of Dartmouth College, and now in the employ of the Missouri Pacific Railway, has been appointed instructor in civil engineering in the James Millikin University at Decatur, Ill.

S. H. Reck, of the Rockford Drilling & Machine Co., Rockford, Ill., sailed from New York August 26 on the *La Lorraine* for a two months trip in Europe. Mr. Reck expects to visit the various machine tool agencies in England and on the continent.

F. C. Armstead, supervising engineer of the stoker department of the Westinghouse Machine Co., who, for a number of years, has been located at East Pittsburg, Pa., has moved his headquarters to the Westinghouse Works, Attica, N. Y., where the stokers are manufactured.

Charles M. Robertson, formerly superintendent of the Colburn Machine Tool Co., Franklin, Pa., will henceforth be associated as special representative and expert with the E. L. Essley Machinery Co., 62 West Washington St., Chicago, selling agent for the Colburn Machine Tool Co. Mr. Robertson has a large and varied experience in the manufacturing and selling of vertical boring mills.

W. R. Chapin, who has been for five years connected with the Cleveland Twist Drill Co., Cleveland, Ohio, has engaged with E. C. Atkins & Co., saw manufacturer, Indianapolis, Ind. While with the Cleveland Twist Drill Co. Mr. Chapin was in charge of the chemical laboratory, heat treatment and experimental departments, and will have a similar position with E. C. Atkins & Co.

Charles T. Hawley, of Gardner, Mass., has been appointed assistant examiner in the patent office at Washington, and has, therefore, resigned from an important position with the Simplex Time Recorder Co., of Gardner, Mass. Mr. Hawley has been active as an inventor, and was formerly connected with the experimental department of the Draper Machine Co. of Hopedale, Mass. He graduated in 1898 from the Worcester Polytechnic Institute.

E. H. Fish, well known to the readers of Machinery as a frequent contributor to its columns, has been elected director of the new Worcester Independent Industrial School. For nine years Mr. Fish was associated with his father, Henry C. Fish, in the machine tool manufacturing business in Worcester, producing a line of engine lathes. Later he went to the Worcester Polytechnic Institute—from which he graduated in 1892—as instructor. He has been instructor in various subjects, and his experience in this work make him particularly fitted to take charge of a trade school designed primarily for the education of mechanics.

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OBITUARIES

T. H. Sears, builder of machinery, Holyoke, Mass., died July 30, aged fifty-eight years.

Fred W. Ridlau, treasurer of the Superior Grate Co., of Springfield, Mass., died July 27 at the age of thirty.

Levi M. Brown, who for more than thirty years was superintendent of the Gilbert & Barker Mfg. Co., Springfield, Mass., died July 15 at the age of seventy-three.

John Moore, superintendent of the machine shops of the Carnegie Steel Co., at Bellaire, Ohio, died by accident at Wheeling, W. Va., July 26.

Henry Mitchell, well-known as an engraver of seals, medals and coats of arms, died at his home in Chelsea, Mass., August 1, in his seventy-fourth year. He entered the service of the United States Government as official engraver in 1868, and engraved the medals for the Centennial Exposition, 1876, before he was thirty years old.

John Morse Ordway died at his home in Saugus, Mass., July 5, at an age of eighty-six years. He was a graduate of Dartmouth College in the class of 1844, and was, up to three years ago, professor at Tulane University, New Orleans. He has also been a member of the faculty of the Massachusetts Institute of Technology.

David H. Gildersleeve, mechanical engineer, died at his mother's home, 104 Montague St., Brooklyn, July 30, aged forty-one. For five years Mr. Gildersleeve was sales manager for the C. W. Hunt Co. Early in 1909 he became vice-president of the Waters, Gildersleeve, Colver Co., in the shipbuilding and marine machinery business. He is survived by a widow and two children.

Leffert Lefferts Buck, a well-known civil engineer, who was associated with Roebling in the building of the Brooklyn bridge, and who was engineer of the Williamsburg bridge across the East River, New York, died at Hastings, N. Y., July 17. Mr. Buck also designed two steel arch bridges across the Niagara river, and had direction of many other engineering works of note both in this country and South America.

Roderick Perry Curtis, president of the Curtis & Curtis Co., Bridgeport, Conn., died at Southport, Conn., August 9, aged fifty-nine, as a result of injuries received in an automobile collision at Westerly, R. I., a few weeks previous. Mr. Curtis was born in New York, from where his family moved to Southport, Conn., in 1868. In 1882 he founded, with William D. Forbes, the firm of Forbes & Curtis, for the manufacture of the Forbes patent die stock. In 1887 the Forbes interests were taken over by Mr. Lewis B. Curtis and the firm of Curtis & Curtis formed to continue the business. In 1900 the firm was incorporated under the name of the Curtis & Curtis Co. Mr. Curtis was also director of several other manufacturing corporations.

Albert A. Pope

Albert A. Pope, pioneer bicycle manufacturer of the United States, died at his summer home in Cohasset, Mass., August 10. He was born in Boston in 1843, and at the age of nineteen he joined the volunteer force of the Union army, and was made lieutenant-colonel in 1865. In 1876, at the Centennial exposition in Philadelphia, he first saw a bicycle. Early in 1877 he organized the Pope Mfg. Co., and as soon as the company was organized he went to Europe to study the development of the bicycle and its possible manufacture in America. In 1878 he placed an order for the manufacture of bicycles with the Weed Sewing Machine Co., which concern he finally bought out, merging it with the Pope Mfg. Co. The business grew rapidly until, after twenty years, it comprised five large factories. In 1896 Col. Pope formed the Columbia Electric Vehicle Co., of Hartford, Conn. In 1899 the Pope Mfg. Co. was absorbed by the American Bicycle Co., but in 1903 the Pope Mfg. Co. was re-organized, and the factories became largely devoted to the building of automobiles. A lull in the motor car business proved unfortunate for the company, and after a period of financial readjustment, the company was again reorganized and incorporated last December under the laws of Connecticut. Col. Pope was prominent in many other industrial undertakings, and was also a director of several banks and other corporations.

Frank L. Bliss, president of the Ajax Iron Works, Corry, Pa., died in Corry, August 3. Mr. Bliss was active in the management of the company since its organization.

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COMING EVENTS

September 14-16. Fourteenth annual convention of the International Association of Municipal Electricians, Atlantic City, N. J. Frank T. Foster, secretary, Corning, N. Y.

September 25-October 9.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one-hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the *Tribune* building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

September 27-October 1.—Autumn meeting of the Iron and Steel Institute, London. G. C. Lloyd, secretary, 28 Victoria St., London, S. W.

October 3-9.—St. Louis Centennial Week, St. Louis, Mo. Balloon, airship and aeroplane races will be arranged under the auspices of the Aero Club of St. Louis.

October 4-8.—Annual conventions of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

October 12-13.—Convention of National Machine Tool Builders' Association, New York. P. E. Montanus, secretary, Springfield, Ohio.

October 14.—MACHINERY'S seventh annual outing.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Viewger, American manager, 50 Church St., New York.

NEW BOOKS AND PAMPHLETS

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS, Park Row Building, New York. Journal containing the constitution and list of members.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th St., New York. Pocket list of the 3,680 members, including the life members. The list appears in a new form, better adapted to the side pocket than the former shape, it being 4¼ x 6½ inches, or "standard" pocket-book size.

DICTIONARY OF CHEMICAL AND METALLURGICAL MATERIAL. 182 pages, 4½ x 7½ inches. Published by the *Electro-Chemical and Metallurgical Industry*, 239 W. 39th St., New York City. Price $0.50.

This dictionary contains an alphabetically arranged list of chemical and metallurgical machinery appliances and material, manufactured and sold by advertisers in the *Electro-Chemical and Metallurgical Industry*. It is divided into three sections, the first or main section being a dictionary of industrial supplies, the second section giving a finding list of manufacturers of measuring instruments and laboratory supplies, while the third section is given up to a professional dictionary of metallurgical, analytical and engineering chemists, consulting engineers and patent lawyers.

WORKSHOP RECEIPTS FOR MANUFACTURERS AND SCIENTIFIC AMATEURS. VOLUME 1. 532 pages, 4¾ x 7¼ inches. Published by Spon & Chamberlain, 123 Liberty St., New York. Price $1.50.

The older edition of "Workshop Receipts" has, during the past few years, grown into five bulky volumes, and the present edition therefore has been thoroughly revised and a great number of the receipts that seemed obsolete have been omitted. The remaining matter has then been carefully revised. The arrangement of the book is alphabetical, and the present volume treats of subjects from Acetylene Lighting to Drying. Outside of the alphabetical arrangement of subjects, a very complete index is given, which will be of considerable aid in finding certain subjects which have not been given a special heading in the main text.

ELEMENTARY PRINCIPLES OF INDUSTRIAL DRAWING. By George Jepson. 29 pages, 8 x 6 inches. 11 plates of illustrations. Published by the author, Roslindale, Boston, Mass.

The object of this book is to present the subject of industrial drawing by such a method that the student will master the fundamental principles without a great deal of preliminary study. Special efforts have been made to make the descriptive matter as short, simple and concise as possible, and to let the drawings largely explain the principles involved. The book should be of great value to beginners as well as to teachers of geometrical drawing, who desire to get a clear conception of the simplicity of the subject when viewed from the position of the practical user of mechanical drawing, rather than from the point of view of the mathematician or student of the theory.

A PRIMER OF THE CALCULUS. By E. Sherman Gould. 122 pages, 3¾ x 6 inches. 24 line engravings. Published by D. Van Nostrand Co., New York. Price $0.50.

This book, which is at present in its fourth edition, is No. 112 of the Van Nostrand Science Series. The work treates of calculus as far as the first differentials of algebraic functions of one independent variable, and their corresponding integrals. It is thus restricted to the first principles of the subject, but within its limits, however, it is reasonably complete and gives the beginner a clear idea of the far-reaching importance of calculus, even in its elementary steps. The book may well be recommended to students who want to acquire a general working knowledge of calculus and desire to become familiar with its fundamental principles.

STEAM POWER PLANT PIPING SYSTEMS. By William L. Morris. 490 pages, 6 x 9½ inches. 389 engravings. Published by the McGraw-Hill Book Co., New York. Price $5.

In this work the author has taken up the design, installation and operation of piping systems for power stations, giving a detailed and consecutive treatment of the entire subject. Only such parts of the power plant are dealt with as are directly related to the piping system. The design of boilers and engines has not been touched upon, as being outside the limits of the treatise, but their operation has been covered. All auxiliary apparatus in the pipe circuit between the boiler and engine and in the various piping systems for steam, oil, air, etc., are also described, and their general design discussed. The book embodies the personal experience of the author and is written from his own point of view. The main subjects of which the book treats are as follows: Piping diagrams and systems; condensers and heaters; live steam drips; blow-off and exhaust piping; air and oiling systems; oil and water purifying systems; details of piping arrangements for live steam, vacuum and atmospheric exhaust, boiler feed, fire pump suction, heater water supply and condensation, air and vacuum lines; city water piping; artesian water piping; fire service piping; hydraulic elevator piping; tile sewers and sundry minor piping details.

CATALOGUES AND CIRCULARS

TRENTON ENGINE CO., Trenton, N. J. Catalogue illustrating the Reeves compound and single cylinder steam engines.

PROTECTIVE VENTILATOR CO., 129-133 Fulton St., New York. Circular and leaflets advertising protective window ventilators.

AMERICAN BLOWER CO., Detroit, Mich. Card advertising the Detroit trap system for boiler feed, water lift and coil drainage.

FIRTH-STERLING STEEL CO., E. S. JACKMAN & CO., agents, Chicago, Ill. Circular of Blue Chip high-speed steel.

INGERSOLL-RAND CO., 11 Broadway, New York. Catalogue describing the construction of rock drills and drill mountings.

H. W. JOHNS-MANVILLE CO., 100 Williams St., New York. Folder describing safety blow-off sectional pipe covering, giving price list and directions for applying the covering to pipes.

SUCRO FILTER CO., 42 Broadway, New York. Catalogue of Sucro water coolers and filters, and filtration plants, showing a number of interesting devices for purification of drinking water.

AMERICAN TAP & DIE CO., Greenfield, Mass. Catalogue No. 3 of "Adamantine" screw plates, "Eagle" brand taps and dies, stocks and tap wrenches; also pipe tools, comprising stocks, taps and reamers.

ABBOTT BALL CO., 14 Hicks St., Hartford, Conn. Circular describing the use of the Abbott steel balls for finishing metal goods by the burnishing and tumbling process, using the Abbott tumbling barrel.

E. W. BLISS CO., 5 Adams St., Brooklyn, N. Y. Catalogue of Bliss steam turbines, describing the construction of the Bliss turbine and calling attention to the advantages of turbines over reciprocating engines.

FULLER & JOHNSON MFG. CO., Madison, Wis. Circular illustrating and describing the Fuller & Johnson diaphragm bilge pump outfits. A general description of the engine and pump is given, and the cost of operation is stated.

JNO. HY. ANDREW & CO., Ltd., Toledo Steel Works, Sheffield, England. Booklet giving information relating to the Toledo high-speed steel and instructions regarding its hardening, together with notes on the forging and tempering of the regular Toledo carbon tool steel.

KEUFFEL & ESSER CO., Hoboken, N. J. Leaflet calling attention to the fact that during the summer months quick-printing blue-print paper should not be carried in stock more than one month, because the heat and moisture at this time of the year is detrimental to the paper.

GENERAL ELECTRIC CO., Schenectady, New York. Bulletin No. 4675, describing and illustrating a new single-phase induction motor of the repulsion induction type, designated as the type RI. Bulletin No. 4677, containing data relating to the Sprague-General Electric Type M system of control.

RUSSELL, BURDSALL & WARD BOLT & NUT CO., Port Chester, N. Y. Catalogue of bolts and nuts, comprising Philadelphia turned head eagle carriage bolts, turned bevel head carriage bolts, loom bolts, cold punched square and hexagon nuts, square head cap screws, machine screws, rivet heads, etc.

H. W. Johns-Manville Co., 100 William St., New York. Circular describing and giving prices of the J-M brickline asbestos firebrick cement for setting up bridge walls and inner courses in boiler settings. This cement is of a semi-liquid consistency, ready for immediate application in setting up firebrick in every kind of service.

A. Bollinckx, Huyssinghen, near Hal, Belgium. Pamphlet reprinted from article by Prof. François of the University of Brussels on the Bollinckx gas motors and gas producers, which first appeared in the *Revue Universelle des Mines*. The pamphlet is in French. Copies will be sent to interested parties free of charge.

Remington Tool & Machine Co., 50 Congress St., Boston, Mass. Circular illustrating the Remington twist drill grinding gage, coil spring winder and micrometer surface gage. The spring winder can be used in the lathe or vise and enables perfect extension, compression and torsion springs to be wound on a mandrel without other appliance.

Graham Mfg. Co., Providence, R. I. Circular of pressed steel grinder chucks for disk, guide bar, knife, and other face grinders. These chucks, for holding wheels for face grinders, are designed without external projections and are safe, light and simple in their construction.

W. S. Rockwell Co., Hudson Terminal Building, 50 Church St., New York. Folder referring to, and giving sizes of, Rockwell muffle furnaces for assaying and other work using oil or gas fuel. If oil is used the pressure may be five pounds per square inch or higher, while air at two pounds pressure is satisfactory.

Hill Clutch Co., Cleveland, Ohio. Pamphlet devoted to line shaft bearings, describing the Hill collar oiling bearing, and calling attention to the products of the Hill Clutch Co., consisting of power transmission machinery, rope transmission, gears, bearings, friction clutches, shafting, pulleys, belt tighteners and fly-wheels.

Cleveland Twist Drill Co., Cleveland, Ohio. Folder No. 930 illustrating and listing the high-speed "Flat-twist" drill with "Paragon" flat taper shank. This drill is twisted from a flat bar instead of being made from the round stock, and is an old design made by the company thirty-five years ago, but recently revived on account of the requirements of high-speed drilling.

Hess-Bright Mfg. Co., 21st and Fairmount Ave., Philadelphia, Pa. Card showing view of buildings of the new ball-bearing section of the Deutsche Waffen und Munitionsfabriken at Wittenau, near Berlin. The Hess-Bright Mfg. Co. controls the output of this plant in the American market, and also manufactures under this plant's as well as its own patents.

Triumph Electric Co., Cincinnati, Ohio. Bulletin No. 371 describing the Triumph adjustable speed commutation pole motors, which are particularly suitable for machine tool drive. On account of the commutation pole construction, sparking is eliminated in these motors within the limits of the capacity of the motor. They are built in all standard sizes from ½ horse-power upward, with speed variations of 1 to 2, 1 to 3 and 1 to 4, and are capable of heavy overload.

Seneca Falls Mfg. Co., 330 Water Street, Seneca Falls, N. Y. Catalogue No. 22-B illustrating and describing the "Star" 9- and 11-inch screw-cutting engine lathes, the "Seneca Falls" 12-, 14-, and 16-inch screw-cutting engine lathes, speed lathes, wood-turning lathes, and attachments. This catalogue describes in detail the improvements introduced in the new designs of the company's machines.

Hess-Bright Mfg. Co., 21st and Fairmount Ave., Philadelphia, Pa. Circulars giving data relating to thrust collar ball bearings, sliding shafts journaled in rotary ball bearings, ball bearing pillow blocks, rollers mounted on ball bearings, two direction thrust bearings, inclined, vertical or horizontal shaft mountings, vertical bevel gear mounting, and pillar crane with ball bearing thrust mounting.

Woburn Gear Works, 32 Nashua St., Woburn, Mass. Catalogue of gears, sprockets, and chains, giving price list and other required information of the company's products of spur gears, bevel gears, miter gears, worms, worm-gears, pinion wire, racks, ratchets, chains, sprockets, pulleys, shafting, collars, and regular and ball bearings. The company is prepared to make all kinds of gears including rawhide and fiber gears.

Cleveland Punch & Shear Works Co., Cleveland, O. Catalogue of machines and small tools, devoted particularly to standard dies and punches, punching machines, coping machines, plate shears, bending rolls, rotary planers, etc. The catalogue also contains a number of useful tables, and a number of pages are devoted to specimen drawings of dies and punches on which the customer has only to fill in the required dimensions for the material he wants to order.

Chain Belt Co., Park St. and 11th Ave., Milwaukee, Wis. General catalogue No. 37 of elevating, conveying and concrete machinery, including elevators, conveyors, chains, chain belts, sprocket wheels and various attachments, gearing, pulleys, bearings, etc. A line of concrete chain-belt mixers is also included. The catalogue comprises 303 pages printed on coated paper and handsomely bound. It is well indexed and is therefore conveniently used for reference.

Gisholt Machine Co., Madison, Wis. Circular describing micrometer index dials and automatic feed trips used on Gisholt boring mills. The time-saving features of these attachments will at once appeal to the shop man. By means of the automatic feed trip either head of the machine may be set to a given trip at a given point, and the operator may attend to other work in the meantime with absolute confidence that when the desired point in the cut has been reached, the feed will stop automatically.

Cincinnati Electrical Tool Co., 650-652 Evans St., Cincinnati, Ohio. Catalogue of "Peerless" portable electric drills, reamers, and grinders, illustrating the line and uses of same. The tool-post grinders made for both internal and external work are of particular interest to the machinist. These electrically driven grinders are mounted in the tool-post of an engine lathe, planer or shaper, and thus convert standard machine tools into fairly efficient grinding machines for circular or flat work.

New York Leather Belting Co., 51 Beekman St., New York. Pamphlet entitled "From Forest to Factory," containing a description of balata and balata belting. Balata is the milk of the boela tree from Guiana and Venezuela. The pamphlet contains interesting information regarding the gathering of balata and the manufacture of balata belting. It illustrates a number of interesting installations, many of which are very trying to belting in general. A perusal of the pamphlet will repay all who are concerned with the problem of power transmission. Sent free on request.

Walton Co., Hartford, Conn. Circular illustrating and describing the Walton extractor for broken taps. This device consists principally of four prongs or fingers of crucible steel, shaped to fit the flutes of the tap and adjustably mounted in a grooved holder which is squared on its outer end for a tap wrench. When a broken tap is to be removed the four fingers are pushed into the flutes after some of the chips have been removed, and the tap is then screwed out by applying a wrench at the outer end of the tool.

Nelson Valve Co., Chestnut Hill, Philadelphia, Pa. Catalogue of bronze valves, iron-body and steel valves, and accessories and fittings. This catalogue lists a great number of different types of valves, including combination globe and angle valves; cup, vertical and swing check valves; union bonnet globe, angle and cross valves; bronze, iron and steel gate valves; gate valves hydraulically, electrically and gear-operated; and valve wheels, disks, floor stands, steel fittings, companion flanges and drilling standards. The catalogue is printed on heavy coated paper and handsomely bound in cloth. It is provided with a complete index, making it convenient for reference purposes.

General Electric Co., Schenectady, N. Y. Booklet No. 3839 illustrating and describing 8- and 12-inch fans for alternating and direct current. Bulletin No. 4665, entitled "Electric Operation of Pulp and Paper Mills," illustrating the application of the electric motor to the paper industry. Bulletin No. 4688 describing a new meter board made of molded material intended to replace the customary wooden board used in mounting meters. Bulletin No. 4680, entitled "Sign Lighting with Tungsten Lamps." A small folder and a booklet have also been issued relative to the new G. E. tungsten lamps.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No. 74 on the Watson-Stillman hydraulic beam shear and the Watson-Stillman hydraulic coping machine. The beam shear has cutting blades which first penetrate the web and are then deflected sidewise by means of a wedge, thus cutting the flanges of the beam last. The hydraulic coping machine is employed for trimming structural shapes, cutting out sections from the flanges, and doing other work necessary in the joining of structural shapes in steel mills, ship building plants, structural iron, boiler and locomotive shops, and wherever splices, connections or cuts are required.

American Oil and Supply Co., 52-56 Lafayette St., Newark, N. J. Catalogue No. 1 of fine tools, machinery, supplies and specialties for jewelers, silversmiths, dentists, opticians, engravers and metal workers. This is a large cloth-bound catalogue of 638 pages, listing the complete line of the goods which the company handles. A carefully prepared index makes it easy to find any matter to which one wants to refer. The tools listed which will be of particular interest to the machinery trade are, among others, blow pipes, micrometers, calipers and caliper squares, oil stones, drill chucks, dividers, drills, emery wheels, files, flexible shafts, countershafts, gas forges and melting furnaces, gages of various descriptions, grindstones, hammers, etc. The catalogue has been compiled by Mr. H. M. Crouse, of the Henneberry Co., Chicago.

MANUFACTURERS' NOTES.

Crocker-Wheeler Co., Ampere, N. J., will open an office in the Ford building, Detroit, Mich., about September 10. Mr. Charles W. Cross will be the manager of this branch.

Muralt & Co., engineers, 114 Liberty St., New York, have been awarded the contract for furnishing and installing the electric equipment of the new municipal lighting and pumping plant at Berlin, Md.

General Electric Co., Schenectady, N. Y., is now making tantalum lamps adapted for voltages from 200 to 250. The tests undertaken have shown satisfactory results, the life of the new lamps averaging fully that of the regular 100- to 130-volt tantalum lamps.

Electrical Alloy Co., Morristown, N. J., has been organized for the manufacture of electric resistance materials. The officers of the corporation are H. P. Reigart, president; F. S. Reigart, secretary and treasurer; and William F. Smith, general manager.

Cincinnati Iron & Steel Co., Cincinnati, Ohio, district sales agent for the Lackawanna Steel Co., is improving its present warehouse equipment; it is installing a large machinery warehouse and remodeling its office building situated at the corner of Front and Freeman Sts.

International Acheson Graphite Co., Niagara Falls, N. Y., is enlarging the capacity of its branch works at Niagara Falls, Ont. A new furnace room, providing for a 1,000 horse-power unit is being built, and upon completion of this, the new installation will be put in operation.

W. M. Nones, 27-29 Water St., New York, who represents American machinery and machine tools in Europe will return to England in October. Mr. Nones is in a position to handle one or two more specialties for American manufacturers, especially labor-saving devices and machines.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., maker of electric controlling devices, announces the opening of a Philadelphia office at Room 1207, Commonwealth Building. An engineer specially qualified to advise regarding the control of electric motors will be in charge of the new office.

F. S. Walton Co., Philadelphia, Pa., manufacturer of Oxoilox belt dressing, reports that this dressing is attaining a wide sale abroad, and that one firm in Russia alone orders four barrels a month. This belt dressing contains as its basic ingredient neatsfoot oil, which is one of the best materials for keeping belts pliable.

Frank B. Gilbreth, 60 Broadway, New York City, has been awarded the contract for the construction of a hydro-electric power development across Paulin's Kill, Columbia, N. J., for the Warren County Power Co. The contract includes the construction of a Ransom hollow dam, 30 feet high and 350 feet long, and a reinforced concrete power house and tail-race.

Colburn Machine Tool Co., Franklin, Pa., builder of vertical boring and turning mills, will, after September 1, be represented in the Chicago territory by the E. L. Essley Machinery Co., 62 West Washington St., Chicago. Mr. Charles M. Robertson, formerly superintendent of the Colburn Machine Tool Co, will be associated with the Essley Co. as special representative and expert. A representative line of boring mills will be carried in stock in Chicago, and machines will be shown in operation.

Westinghouse Storage Battery Co., Boonton, N. J., was incorporated July 12th, and has acquired all of the plant, patents and equipment of the storage battery department of the Westinghouse Machine Co., and of the General Storage Battery Co., and will manufacture both the Westinghouse and Bijur types of storage battery for those classes of service in which each has proved superior. The general offices of the company will be located at Boonton, N. J., with sales offices in the principal cities of the country.

Frank Mossberg Co., Attleboro, Mass., has begun building a new factory, consisting of a main building 290 x 60 feet and a power building 150 x 60 feet. The new factory will employ over 250 men, and is to cost $50,000. The factory building is a two-story brick building, the lower floor being used entirely for the presses and heavy machinery, and the second floor for light manufacturing purposes, tool making, and assembling, as well as for office and drafting room. The company's main product is metal-stamping work of all kinds.

Crocker-Wheeler Co., Ampere, N. J., has recently booked several large orders for direct current apparatus, including one from the Indiana Steel Co., calling for seventy mill motors totaling about 2,400 H. P. This order is an addition to the 11,000 H. P. of Crocker-Wheeler motors employed at the present time by this steel company. The Bethlehem Steel Co. has recently added to 8,800 H. P. of Crocker-Wheeler motors by an order for a 225 H. P. compound wound motor to be installed at the Saucon plant.

T. R. Killilea, 229 West 101st Street, New York City, has developed a new belt dressing consisting of a "processed" vegetable oil which preserves the fiber, not having the rotting effect of neatsfoot oil. It contains no resin or gum, and is particularly well adapted for use in textile mills, factories, shops and other places where it is highly necessary that no stain or grime be cast on the fabrics by the belts. The Killilea dressing does not stain fabrics even if directly applied as it can be washed away with a little soap and warm water.

Manufacturers' Publicity Corporation has been organized by Benjamin R. Western and W. Hull Western (until August, 1909, proprietor and manager, respectively, of the Manufacturers' Advertising Bureau) and Walter Mueller and W. H. Denney, president and treas-

CONTENTS FOR SEPTEMBER

urer, respectively, of the Banning Co. The new corporation will take charge of the advertising interests heretofore directed by the two companies. The offices are located in the Hudson Terminal Building, 30 Church St., New York.

Western Electric Co., 463 West St., New York, has obtained a contract from the Chinese Government to supply a complete telephone plant for Pekin. Two exchanges have been ordered, but this is only considered as the beginning of a system which will eventually be fully developed throughout China. The order covers a complete telephone plant of modern type, including several hundred thousand feet of lead-covered aerial and under-ground cable. The order amounts to about $150,000, and the work of installation will be done under the supervision of one of the Western Electric Co.'s engineers, who will be sent to Pekin for that purpose.

The September *Century* contains at least one article—"The World's Greatest Aqueduct," by Alfred Douglass Flinn, Eng., which should be read by every engineer and every man interested in engineering projects. The Catskill Mountain Water System, now being built for New York City, is one of the greatest engineering enterprises ever undertaken. It ranks with the interoceanic canals at Suez and Panama, the Assuan irrigation work in Egypt, and those projects which are converting the arid wastes of the West into fruitful tracts, and with its tributary reservoirs and adjuncts probably surpasses any of them in the variety of problems to be solved. Imperial Rome's longest aqueduct was 57 miles, the Catskill aqueduct will be 92 miles in length. The estimated cost is $162,000,000, but when completed this supply will mean 500,000,000 gallons of water a day, against the present 336,000,000 gallons daily, given by the Croton System.

. RAILWAY MACHINERY

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics

October, 1909

MALLET COMPOUND FREIGHT LOCOMOTIVE FOR THE ROYAL HUNGARIAN STATE RAILWAYS

A MALLET compound locomotive which is to be used for freight service on the Royal Hungarian State Railways is shown in the illustration, Fig. 1. This engine has six pairs of driving wheels divided into two separate sets, the rear set being driven by the high pressure cylinders, and the front set by the low pressure cylinders. The front frame in which the three front drivers are located, is connected to the rear frame, containing the rear wheels, by a joint which enables the front frame to move laterally when the engine strikes a curve. The boiler is supported on the rear frame by cast steel brackets which are so designed that they permit of any expansion or contraction which may take place because of temperature changes. The front part of the rear frame extends for some distance over the front frame as shown in the illustration. This extension is supported by a cast steel bracket which rests on the rear part of the front frame. This is not only to throw some of the weight of the rear frame and its parts onto the front frame, but also to more fully support the boiler. This cast steel bracket is not rigidly connected with the front frame, but it has on its lower end a flat surface which rests on a corresponding flat plate attached to the frame beneath, thus permitting a lateral displacement of the latter. The construction of the bracket and bearing is shown in Fig. 2. The springs *S* which are attached to the front frame, bear against pins located on either side of the cast steel bracket as shown in the end view. These pins are in contact with the lower end of the bracket, as shown, so that the springs not only absorb the shocks which would otherwise occur in the jointed frame connection on level stretches, but they also aid in bringing the front and rear frames in proper alignment after the engine leaves a curve.

The boiler is built up of three sections each of which is made of heavy plate 17 millimeters (0.669 inch) in thickness. The horizontal seams are doubled-lapped and have three rows of riveting. The sand boxes are attached to the first and third sections and the steam dome is placed on the middle one, just above the high pressure cylinders. This dome is equipped with two spring-loaded safety valves having graduated scales which give the pressure in the boiler. These scales are clearly shown in Fig. 1, just in front of the dome. In this steam dome there is a water-separating apparatus, which keeps the steam fairly dry. The fire-box has a heating surface of 149 square feet. The three upper rows of stay-bolts in the right and left side-sheets and also the upper rows for the door and tube sheets, as well as the outer vertical rows of all the sheets are made of phosphor bronze. All the other stay-bolts are of copper. The crown-sheet is connected with the outer shell by means of stay-bolts in the usual way. The expansion is taken care of by a set of short hangers which are attached to the front part of the crown-sheet. The smoke-chamber is equipped with wire netting to arrest sparks, which is arranged the same as on American locomotives. The boiler is fed by two Friedmann's injectors, No. 11, of the class known as SZ.

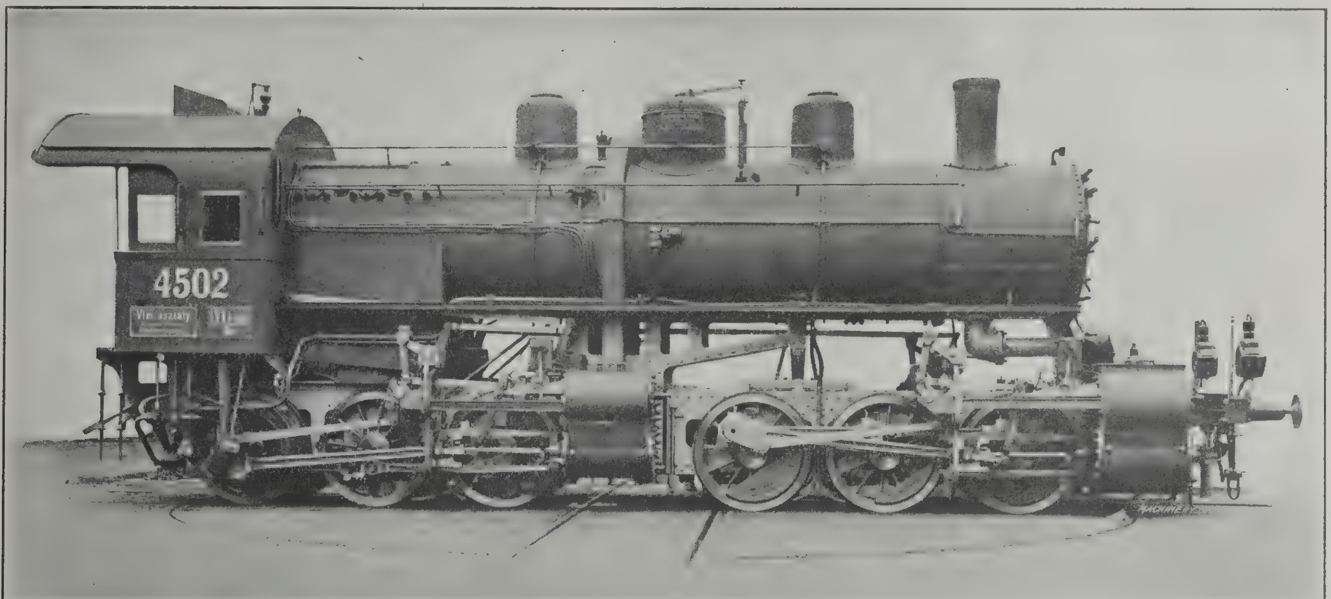

Fig. 1. Mallet Compound Freight Locomotive for the Royal Hungarian State Railways

The steam passes from the dome to the high pressure cylinders through an exterior pipe which encircles the boiler. This pipe, which may be seen in Fig. 1, is 125 millimeters (5 inches) in diameter. The steam is exhausted from the high pressure cylinder into a copper pipe 200 millimeters (8 inches) in diameter which also serves as a receiver. From here it passes to the intercepting valve, and then to the low pressure cylinder. The receiver pipe which connects the exhaust pipe of the high pressure cylinder with the intercepting valve, is capable of both lateral and longitudinal movements, which are, of course, necessary because of the shifting of the frame on curves. The design of the joint where the receiver pipe connects with the high pressure exhaust is shown in Fig. 3. As will be seen, a ball-joint makes it possible for this pipe to swing in any direction, while the necessary longitudinal movement is obtained by a sliding joint, which is made tight by a stuffing box and gland. The receiver pipe is also provided at the front end with a ball joint. As the receiver pipe is of copper, with a thickness of only 5 millimeters (0.196 inch), it is enlarged at the sliding joint end by a bronze bushing. The pipe connecting the exhaust cross-pipe of the low pressure cylinder with the elbow attached to the smoke-chamber, is also provided with sliding and ball-joints, the design

of which is similar to that for the high pressure exhaust connection. These ball-joints are kept tight by babbitt metal rings, which are compressed by the glands shown.

As those familiar with compound engines know, the intercepting valve between the receiver and the low pressure cylinders serves to admit steam directly to the latter from the boiler at the moment of starting. The type of intercepting valve used on the locomotive illustrated herewith is shown in Fig. 4. When the engine is to be started, live steam is admitted, by a starting valve, beneath the large disk valve shown. The pressure causes this valve to rise and close the passage to the receiver so that live steam may flow directly to the low pressure steam chests. This connection between the boiler and the low pressure cylinders is maintained only for a short time, or until sufficient pressure has accumulated in the receiver to enable the engine to work as a compound. The disk valve is then in the position shown in the illustration, which gives the high pressure exhaust a free passage from the receiver to the low pressure steam chest. The existing pressure in the receiver is shown in the engine cab

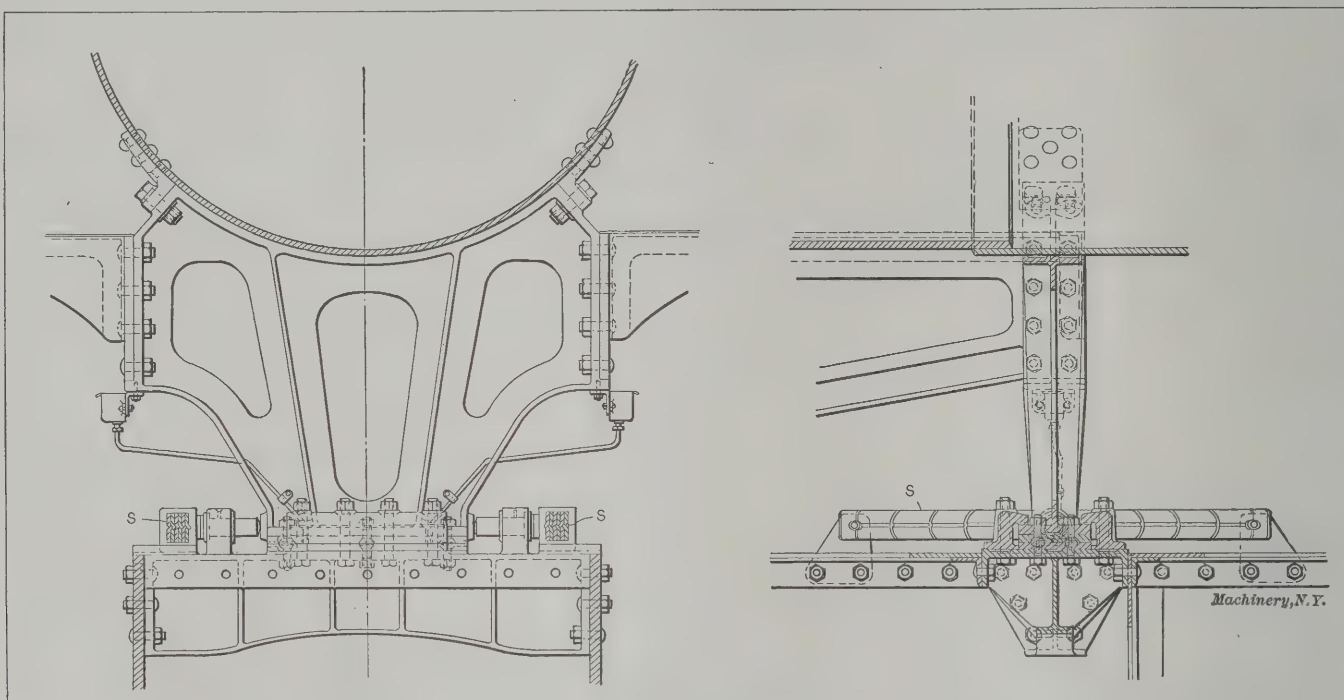

Fig. 2. Boiler Support which rests on the Rear End of the Front Frame

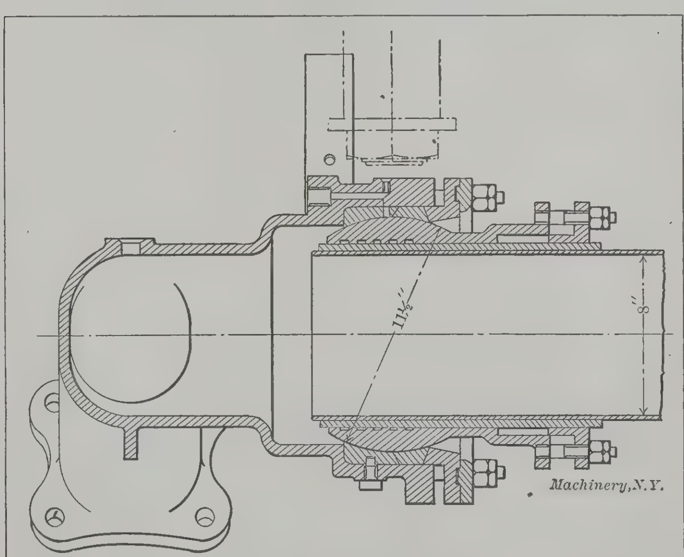

Fig. 3. Ball and Sliding Joint Connection for High-pressure Exhaust

by a gage, which is connected with the intercepting valve by means of a copper pipe. A relief valve is attached to the steam chest of the right-hand low pressure chest, which prevents the pressure in the large cylinders from rising above 102 pounds per square inch.

The high and low pressure cylinders are provided with cast iron piston valves. The piston proper is made in two parts and has cast iron packing rings. The opening at the place where the ring is divided is made practically steam tight by an inner spring ring which prevents the steam from flowing under the outer ring at the joint. The piston-rods of the low pressure cylinders have extension ends which pass through the front heads. These extension rods are not provided for the pistons of the high pressure cylinders.

In order to avoid the vacuum in the steam chest resulting from the suction of the piston when drifting down a grade, relief valves are provided as on American locomotives. As dust and ashes are liable to be drawn into the chest through the exhaust, even when relief valves are used, this trouble is obviated on these engines by admitting a small amount of steam into the exhaust pipe at the proper time. Two Friedmanns' oil pumps, equipped with a heating apparatus, take care of the lubrication of the cylinders and steam chests.

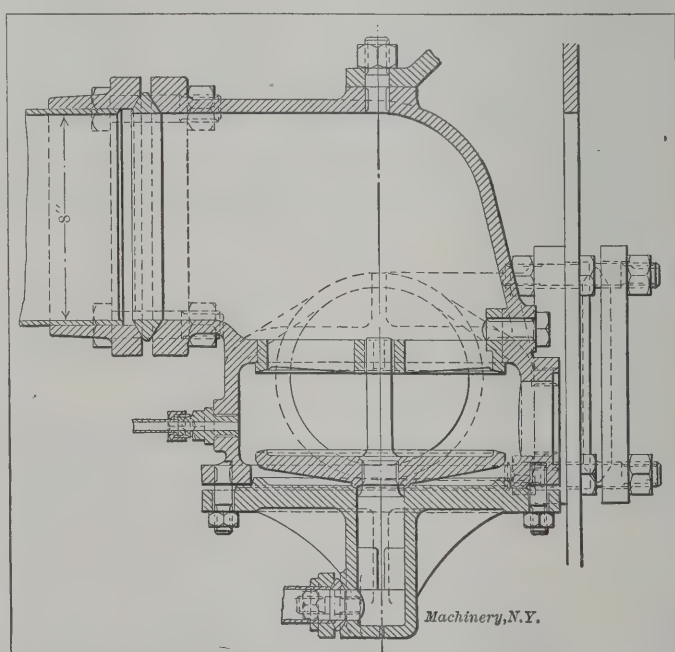

Fig. 4. Sectional View of the Intercepting Valve

The Heusinger type of valve gear regulates the distribution of steam. The arrangement of this valve gear is shown in Fig. 5. Reversing of the engine and changing the position of the lever to vary the point of cut-off is accomplished by a crank and screw. The shifting of the gear for the high and low pressure cylinders is done simultaneously by means of a rod connecting the two tumbling-shafts. The braking appa-

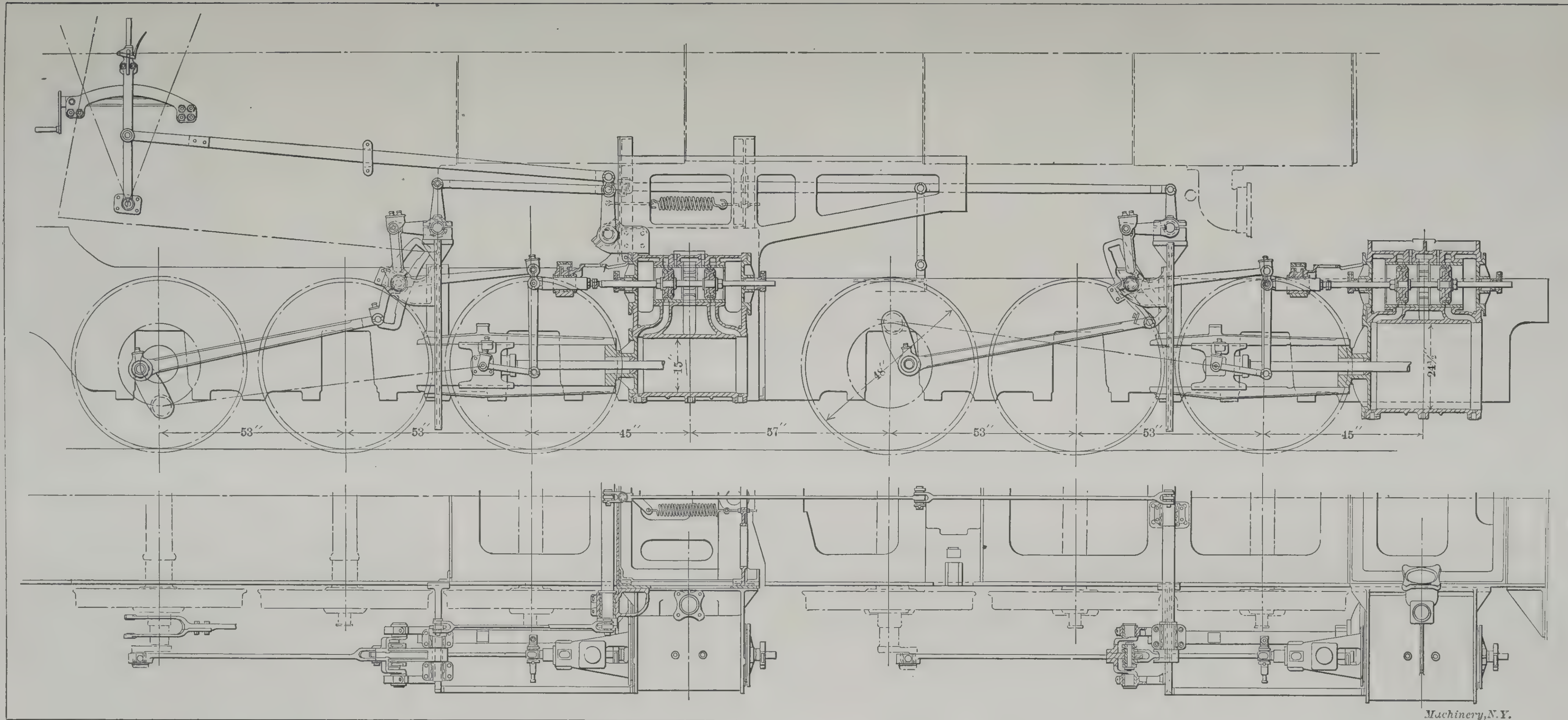

Fig. 5. Plan and Elevation showing the Heusinger Valve Gear, which is Similar to the Walschaerts Type

ratus on the first two locomotives built was of the Lechtelier type. The engines which are now being constructed are equipped with the Westinghouse automatic brake. The flanges of the first and fourth pairs of drivers are provided with a tire lubricating apparatus. The engine also has a pneumatic sander and on the right side there is a Haushälter speedometer. All of the steam pipes except the exhaust pipes have a covering of asbestos wire netting.

The metals used for the main parts of the locomotive are as follows: The boiler, the front tube-sheet, the frame, axles, piston and connecting-rods and also parts of the valve gear are made of open hearth steel. The walls of the fire-box are of copper, and the stay-bolts of copper and phosphor bronze as before stated. The driving wheel centers, part of the frame connections, the "mud" ring, the cross-head and piston bodies are made of steel castings. The cylinders, piston rings and valves are of cast iron.

The tender has six wheels, all of which are provided with brakes. The capacity of the water tank is 14.50 cubic meters (3,800 gallons) and there is a space for coal of 8.2 cubic meters (290 cubic feet). The weight of the tender, when empty, is 15 tons, and when ready for service 36.5 tons. A gage is placed on the water tank so that the fireman may see at any time, without difficulty, the amount of water in it.

The dimensions of the principal parts of these engines are as follows:

Cylinders, diameter, high pressure, 15 inches; low pressure, 24½ inches; stroke, 24 inches; valves, balanced piston.

Wheel base, driving, 26 feet 2 inches; rigid, 8 feet 10 inches; total engine and tender, 46 feet.

Weight of engine, empty, 143,260 pounds; ready for service, 158,688 pounds; total weight of engine and tender ready for service, 239,134 pounds.

Boiler, steam pressure, 235 pounds; number of tubes, 272; outside diameter of tubes, 2 inches; length between tube sheets, 16 feet 5 inches.

Heating surface, tubes, 2,367 square feet; fire-box, 149 square feet; total, 2,516 square feet.

Driving wheels, outside diameter, 48 inches.

* * *

The Pennsylvania Railroad has ordered 200,360 tons of rails for 1910 requirements.

DESIGNING A GASOLINE LOCOMOTIVE

MORRIS A. HALL*

In the article on gasoline locomotives, July, 1909, the writer gave a general sketch of the field of usefulness, the economy, and a brief description, of some of the principal types of machines now on the market. In the present article we will proceed to discuss the time required and material used in designing a four-cylinder machine, from which we shall arrive

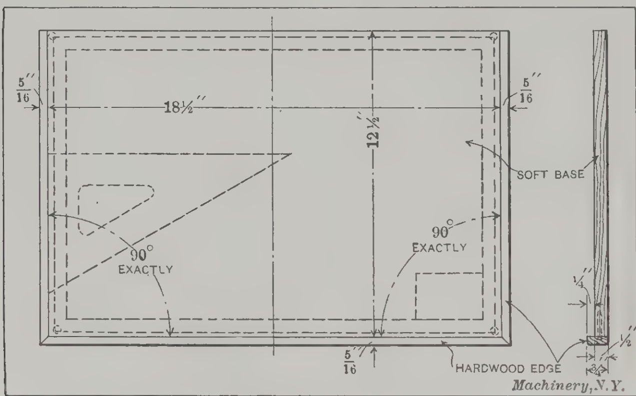

Fig. 1. Type of Drawing-board for Detailing which does not require a T-square

at the total cost of designing. This information may be useful to some manufacturer who is considering the advisability of taking up this work, as very little has been written on the subject of drafting-room costs. A prime reason for this can be found in the fact that in very few drawing-rooms are the draftsmen required to make out time cards; hence the exact time—and consequently cost—cannot be obtained. Similarly with regard to materials the writer has found that very few chief draftsmen will go to the trouble of keeping an exact record of the material used.

MOTOR CAR DEPT.
CAR CO.
THREE RIVERS, MICH.

BILL OF MATERIAL

No. 2 J Motor Car

SHEET NO. 4
4 SHEETS

SYMBOL NO.	NAME	MAT'L.	NO. PER	DRAW. NO.	REMARKS
	Throttle Control Bell Lever Pin	C.R.S.	1	D 2696	5/16" d
G 2303	" " " " C.P.	S	1	D 2696	1/16" d x 1/2"
AG-1136	" " " " Bear.	B	1	D 2697	Use * 10 Mch. So.
	" " Lever	S	1	D 2698	
	" " " Latch Pin	C.R.S.	1	D 2699	Hardened
	" " " Quadrant	M.S.	1	D 2700	
G. 2303	" " " Rod C.P.		3	D 2694	1/16" d x 1/2"
	" " Lever Stop	M.S.	1	D 2701	
	" " Rod Spring	S. W.	1	D 3100	*50 Stubbs (0.069")
	" " Lever Seat	B	1		
	Plate				
G. 1815	" " T. P.		1		* 3 T. P.
AG-1134	Exhaust-Pawl	B	2	D 2703	
	" " Shaft	C.R.S.	1	D 2704	
	Release Lever	M.S.	1		
	" " Taper Pin	S	3		
	" " Quadrant	M.S.	1		
G. 2403	Exhaust Pawl Taper Pin		2		* 1 T. P.
	Assembly		1	AA 130	
	Guide Arm Assembly		1	B 176	

Fig. 2. Bill of Material filled out upon Completion of the Drawings

Let us look first into the drawing-room system in force at the plant where this design was reproduced. The make-up of the drawing-room force consisted of a chief engineer, chief draftsman, senior draftsman or designer, junior draftsman—also a designer—two or more detail draftsmen, two or more tracers, filing clerk, stenographer, record clerk, and blue-print boy. The chief engineer gave the order for the design, with the major points outlined and the approximate date on which it was wanted, to the chief draftsman. The latter was required to have the design complete and ready to send out to the shop on that date. The engineer's time enters into the present discussion in so small a part that it will not be hereafter considered; first, because the amount of time would be hard to estimate, and second, because it would require special classification. The stenographer and record clerk are counted out for the same reasons.

Then the design was usually started like this: The chief draftsman took the order and proceeded to make calculations and sketch out something that very nearly filled the requirements. This was submitted for approval, and upon being approved the work of designing was pushed along as rapidly as possible. The sketches, calculations, etc., were given to one of the designers—either to the senior draftsman (as in this case) or to the junior draftsman, according to the caliber of the job and the arrangement of existing work in the drawing-room. This man made all necessary calculations and checked those previously made; then he started in and designed the complete machine, the various steps in the work being approved from day to day by the chief draftsman. Thus no time was lost. The design having been completed, or nearly so, the detailing commenced. This was done in two ways, the preferred method being as follows: The designer made free-hand sketches of the individual parts on special paper provided for that purpose. When he had finished all of the sketches in a group, he handed them in, and they were looked over, approved, and given out to the detailers and tracers, who drew them up to scale and made cloth tracings. This work was done on special small drawing-boards provided for the purpose. These boards were the writer's design and saved a great deal of time. They have a back of soft lum-

CAR CO.

136-76-5-2

Pattern Order No. P.1892 Date
Symbol No. Section Shelf
Name of Part
Give Correct Technical Name of Part
Used on
Give Number and Name of Machine or Order Number
For Details See
Kind of Pattern Wanted*
Remarks

Pattern Finished Checked by
Ordered by
*Give Specific Instructions, Temporary or Permanent, Wood or Metal, Gated, Etc.

Pattern Order No. P.1892
Mr.
The Pattern called for on above order is finished and ready for approval.
Signed
Foreman Pattern Maker
Symbol Sec. Shelf Date
Name
Used on

Fig. 3. Pattern Order which accompanies a Drawing to the Pattern Shop

ber, white pine or pattern-maker's lumber being the best, and selected soft pieces of poplar being satisfactory. Around the outside of the board or, at least, around three sides (one of the three being parallel to the grain of the wood) is an edge of hard wood projecting above the surface of the board about one-fourth of an inch, as shown in Fig. 1. Great care must be taken to have the two inside surfaces of the projecting strips exactly square, as it is by dependence upon this latter feature that the T-square and the work of handling it can be dispensed with. These boards are made in two sizes, 9⅜ inches by 12⅜ inches inside, which gives ⅜-inch clearance for the smallest-sized standard sheet, viz., 9 inches by 12 inches, and 12½ inches by 18½ inches inside; which gives ½-inch clearance for the next larger standard size; that is, 12 inches by 18 inches. Only one triangle is used; a 30—60-degree being preferable. This must be of such a length as to cover more than half of the longest dimension of the board,

MOTOR CAR DEP'T 197-27-5-2

Blue Print Drawing
Issued to
Order M. C.
Remarks

Rec'd Date

Fig. 4. Blanks issued with Blue-prints to prevent the Loss of the latter where Large Numbers are being used

otherwise the long lines across the board will not lap and consequently one will not be an accurate prolongation of the other. This means that on the 9-inch by 12-inch board a triangle of 7-inch length should be used, and on the larger size one 10 inches long will be necessary. By placing the triangle against the edge of the base or long side we draw all vertical lines, and by moving it over against the sides we draw the horizontals. Thus the T-square and the work of handling it

* Address: 704 W. 180th St., New York City.

are done away with, and the number of articles in use being reduced to a minimum more freedom is given to the hands. In this particular case a further saving was made by marking out on the board at the top and sides, in the most advantageous position, a prolongation of the limit and border-lines of the standard sheet. By so doing, a sheet of paper or cloth may be put down very rapidly and without much care as to position, for when fastened down the scribed lines on the board provide the exact size at once, without any laying out. Not only were these boards used very extensively, each man being provided with one or two, but the writer has one of each

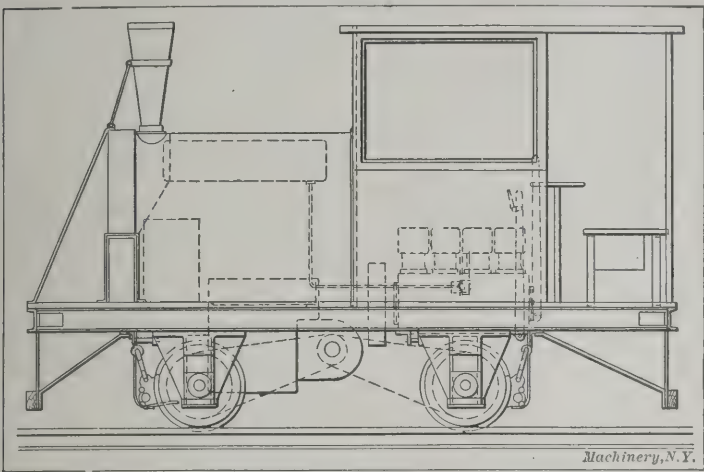

Fig. 5. Side Elevation of a Gasoline Locomotive

of the smaller sizes and an 18 × 24 size as well. The latter requires a very large triangle, and as a 13-inch, the proper size, is not made we had to get a 14-inch.

To go back to our designing: These sketches having been laid out to scale and traced were handed back to the designer, together with the tracings. He checked and corrected the latter and returned them—with his own sketches as a proof of his intentions—to the chief draftsman. In case of a mistake the tracings are first looked up and later, if necessary, the preliminary sketches. The chief draftsman checked the work again, and when all drawings were finished and checked the tracings were given to the filing clerk, who numbered them. Then the bill of material, of which a sample blank is shown in Fig. 2, was filled out complete, and the design was then ready to be sent out to the shop.

When instructions are given to send out the design, which may be done before all tracings are finished—although this is poor policy—the tracings of all parts requiring a pattern are sent to the blue-print room to be printed. With these must go an order for the number of prints required, a duplicate being retained on file. As the order and duplicate both contain the numbers of all tracings, the latter may be checked off when returned, thus minimizing the loss of tracings. The blue-prints, after having been received and checked off, are issued to the pattern shop, along with a pattern order. This blank form consists of two parts, original and duplicate, the former being shown in Fig. 3. The two parts are identical, except that the original is perforated at the left for removal and has in addition a detachable stub seen on right-hand end. The pattern order numbers are carefully stamped beforehand so as to avoid any confusion or duplication of numbers. In use, these orders are bound up in books of one hundred with paper covers, as being handier than loose leaves. The items on the blank are all filled in except "Section" and "Shelf" in the second line, "Pattern Finished" and "Checked by" in the next to the last line, and the stub. A piece of carbon paper slid in between the sheets gives the required duplicate. Then the order is torn out and sent to the pattern shop. When the pattern is finished, the foreman pattern-maker fills out the blank spaces on the order and on the stub. The former he files for future reference, but the latter is returned with the drawing to the drawing-room. If the pattern is a new or very important one the chief draftsman will look at it before allowing it to go to the foundry; otherwise, as soon as the foundry sends for this pattern it will be released.

To take up again the issuing of the blue-prints, additional sets of prints were made and sent to the machine shop and assembling room. One department in this shop (and there were three) issued as a yearly average over 800 prints per month, or 31 per day, so that some system in handling and issuing them was necessary.

In issuing, each blue-print was given a separate number which was entirely distinct from the tracing number. These numbers were taken consecutively and soon ran up into large figures. This was a necessity, however, as before this was done, and the prints charged up to some individual, valuable and important prints frequently and mysteriously disappeared. There were other equally weighty reasons for adding this little bit of red tape. The blank forms shown in Fig. 4 were used, one printed on very thin paper and another on thick cardboard being employed each time. All of the blank spaces were filled out, writing on the thin sheet being done with carbon paper below to copy on the thick one. The former was pasted on the print in a prominent position and the latter fastened to it temporarily with a paper clip. When sending out prints, the filing clerk delivered them, waiting while the thick cards were signed as a receipt. These cards were then brought back to the drawing-room, where they were filed

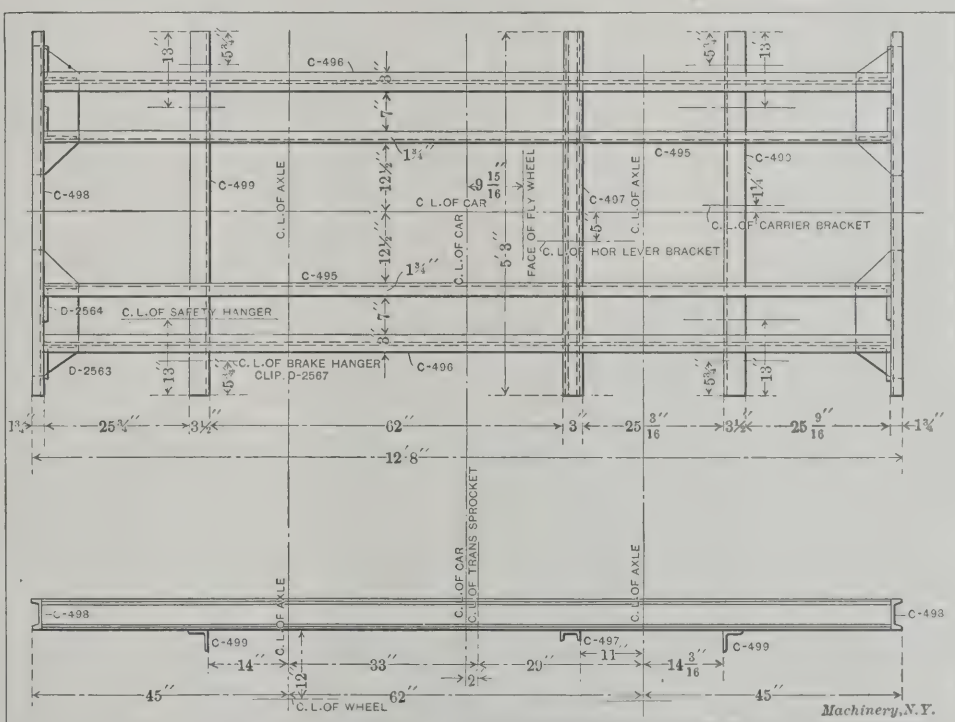

Fig. 6. The Frame of the Locomotive illustrated in Fig. 5

under tracing numbers instead of blue-print numbers. Thus if a tracing was changed it was a very easy matter to locate all outstanding prints of it for revision. The writer has since worked out a simplification of this system for use in a smaller shop where the number of prints issued would not justify so much expense. This was done by eliminating the cards entirely, which was accomplished by stamping the number and date, as well as the signature of the man issuing it, on the back of the blue-print. These same items, with the name of the man to whom it was issued, were recorded in a book. Thus the printing of the cards, handling them and pasting on the prints was all done away with, and, except for the

personal signature indicating the receipt of the print, every good feature was retained.

To get back to our gasoline locomotive, from the time-cards covering this work the number of hours and the cost of the same have been reckoned out and tabulated. This we have shown in a table, in which it will be seen that the work was divided into five main parts, as follows: design, detailing, tracing, checking and supervision, filing and miscellaneous work. These seemed to be the most logical divisions. Of course many others could have been made, as calculation time might have been separated from designing, and checking and supervision might have been split up to make two divisions. Similarly, checking and filing, etc., might have been combined into one item under non-productive work, as contrasted with the other three items, which are all productive. However, as stated above, this seemed a logical way to divide it.

If we may pause a moment to look at these figures we shall notice, first, how few of them balance, even approximately, in the percentage columns. Either the per cent of time or the per cent of cost is higher. These two should balance, for with cost higher the men were apparently paid too much for the work they did; and, vice-versa, with time higher the men were doing more work than they were paid for—or, rather, they were paid less than their work was worth. Thus, taking the item of design, if we grant that the time is O. K. then the cost is too high. Now 41.2 per cent of the cost would be $93.68, which for 250 hours would be but 37½ cents per hour. So if we grant that the time item is correct the designer should have been paid but 37½ cents instead of 43 cents. Similarly in tracing, if we take the time as right the men should have been paid $45.25 instead of $28; or if we take the cost as right the work should have been done in 12.1 per cent of 608, or 73½ hours. Looking over the individual items we notice first how small the proportion of design really is. When we consider that the designer really does all of the work and furnishes all of the ideas, the other and cheaper men simply following his orders, it is seen that the percentage of 41.2 of the total time is low, although it actually is more than two-fifths. Similarly in cost the design runs up to nearly one-half. These low figures for the design were brought about by two things: first, the design was along the same lines as a smaller, lighter machine previously worked out; and second, the engine used was a standard engine and not specially designed for this job.

We come now to the matter of material used. An accurate record of all material was kept, balanced frequently, and averaged. Having thus the average consumption of material per week, all we need to know is the number of weeks worked to arrive at the amount of material used, which is obtained by simple multiplication; thus, average weekly consumption times number of weeks equals total material used. On going through the time record for the period when this design was active we find that the average number of men working was 6.3. This was obtained by counting the number of men at work each week and dividing the sum total by the number of weeks. The number of hours per day was nine and per week fifty-four. Now, 6.3 men working 54 hours each make a total of 340 hours worked per week. The total number of hours spent on this design is from the table 608; so that the equivalent average number of weeks worked was 608 divided by 340, which equals 1.787 or, say, 1.8 weeks. From this and our average weekly consumption we can figure the total. Now having our total material cost and total time cost we may combine these into a grand total for the whole job.

Fig. 5 shows a side view of the complete locomotive. As will be seen from this, the engine, operating levers and engineer were concentrated over the rear axle; while the transmission, radiator and water system, fuel and exhaust system, were disposed over the front axle. Thus the weight was evenly distributed on the two driving axles.

The main frame consisted of two side members of 5-inch I-beams, which carried the pedestals. The ends of the frame were formed of 5-inch channels which were carried out wider than the rest of the frame, as wide as the tread would allow, so that the cab could be full width. The sub-frame on which the engine and transmission were hung was also made of 5-inch channels running the full length. These were set back to back and were cross-braced by the two heavy angles carrying the brake rigging and another angle just forward of the engine. This assembled frame is shown in Fig. 6.

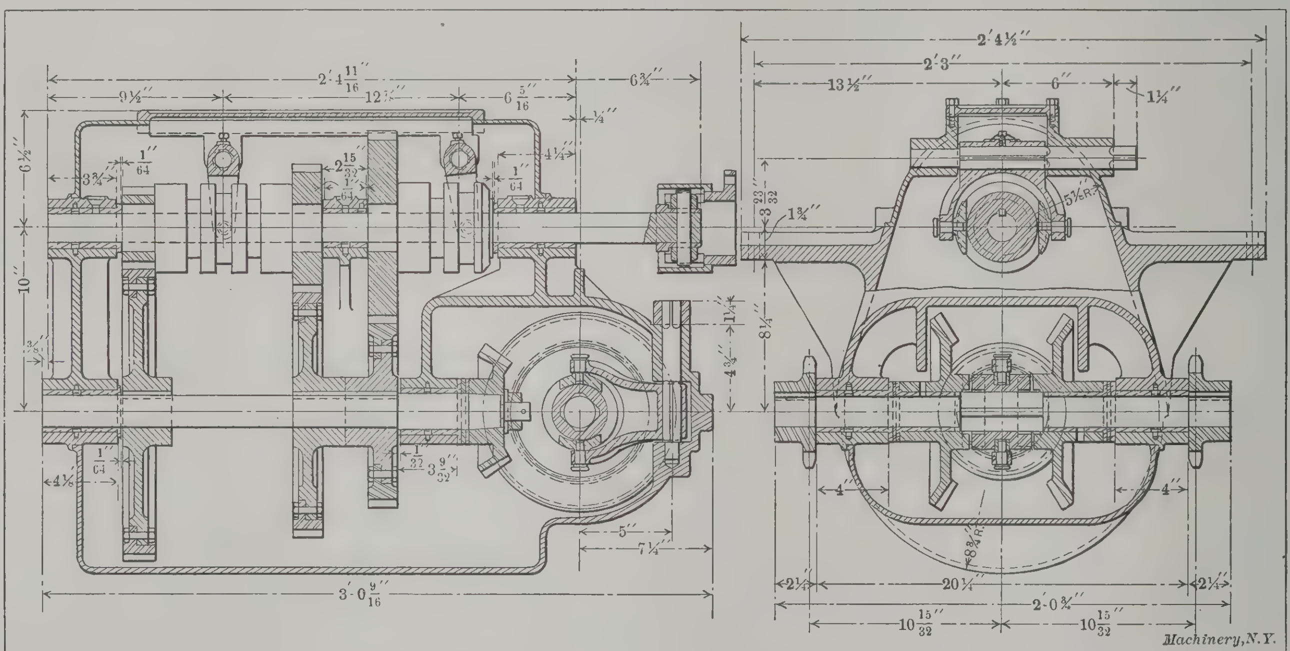

Fig. 7. The Transmission Gearing giving Three Speeds for the Forward and Three for the Backward Movement of the Locomotive

The pedestals follow railroad practice fairly closely but with two differences; roller-bearings were used instead of plain brass boxes, and on account of the chain drive an adjustment was necessary.

The axles were of round stock 2½ inches in diameter, turned to a press fit for the wheels. Owing to inside bearings having been used, it was necessary to slide both bearings and the sprocket hub on to the axle before pressing on the wheels. The two axles are alike and by turning end for end, to bring the sprockets in position, may be used interchangeably.

The engine was the firm's standard four-cylinder, four-cycle, having a 4½-inch bore by 4½-inch stroke, and fitted with jump-spark ignition using a timer of the roller type. No master clutch was used, the transmission being of the individual clutch type so that any speed could be engaged at any time without doing harm. Between the engine and transmission was a combined universal and slip joint to take care of any inequalities in the height of the two when lined up in place.

The transmission shown in Fig. 7 had three speeds, all being operable in both directions, so that to speak correctly we must say that it had six speeds. The mechanism for revers-

ing consisted of three bevel gears, the bevel pinion keyed to the end of the jack-shaft driving two equal bevel gears, which were bushed to run free on the countershaft. By means of a pair of jaw clutches either one of them could be engaged at will. This is shown in the sectional end view at the right of Fig. 7. When the jaw clutches are shifted to the left the locomotive is driven forward, and when shifted to the extreme right the locomotive is driven backward. This is set in the position desired before shifting the other clutches which give the speeds, as otherwise the gears would be moving, offering a chance for breakage of the jaws.

The transmission case was made in three parts, the central or main part, which carried all of the bearings and the supporting arms, being self-contained; that is, the transmission could be operated without the other two portions. These, the lower and upper parts, are only covers; in fact if this machine had been an automobile, where light weight is very necessary, these would have been very thin aluminum or sheet-iron pans. As it was, they were of cast iron and made as thin as cast iron would run. The upper half also carried a large inspection cover, so that the gears or clutches could be inspected or oil and grease put in without taking off the upper part of the case.

The radiator was made very large and was set up high to get as much air as possible. The natural flow of air was further assisted by an air-tight hood, within which the exhaust

TIME AND COST TABLE

Divisions	Hours	Rate per Hour, cents	Total Rate	Cost	Per Cent of Time	Per Cent of Cost
Design	250	43	$107.50	$107.50	41.2	47.3
Details	112	43	48.16	....	....	....
	30	33	9.90	....	....	....
	142	..	58.06	58.06	23.3	25.5
Tracing	4	17	0.68	....	....	....
	8	22	1.76	....	....	....
	24	21	5.04	....	....	....
	35	33	11.55	....	....	....
	50	17	8.50	....	....	....
	121	..	27.53	27.53	19.9	12.1
Checking, supervision, etc	50	56	28.00	28.00	8.2	12.3
Filing, issuing, indexing, etc	45	14	6.30	6.30	7.4	2.8
Total	608	..	.....	$227.39	100.0	100.0

discharged upward into the stack just back of and above the radiator, thus producing an induced draft effect.

The fuel tank was carried over the transmission and well forward, in which position the exhaust pipe passed close enough to warm the fuel, thus aiding carburization.

A large hand wheel in the center of the cab operated all brakes. These were of the standard railroad type, with removable brake shoes. The engineer had one hand wheel, three hand levers, and two small levers to operate. The wheel operated the brakes and so was not in use when the levers were. These gave the different speeds. The outside lever on the right-hand side gave the slow speed when pulled back and the intermediate or second speed when pushed forward. The inside lever gave the high speed when pulled back and was interconnected with the outer lever so that two speeds could not be engaged at once. The other hand lever on the left side gave the forward or reverse motion, a latch and quadrant holding it in forward, neutral, or backward position, as desired. The two small levers operated the spark and throttle, thus regulating the engine speed.

A Brill draw-bar was provided at both ends of the truck, as well as a running-board. The wheels were M. C. B. standard 18 inches in diameter; the gage, standard 4 feet 8½ inches, but adaptable to any gage above 30 inches by using outside bearings. The wheel-base was 4 feet 10 inches. The engine was rated at 25 horse-power but would deliver more; at 1,000 R. P. M. the three speeds were 14.7, and 3½ miles per hour. The length over all was 13 feet, width 5 feet 4 inches, and height without any cab or other covering 5 feet 2 inches.

MANUFACTURING METHODS IN THE STEVENS-DURYEA AUTOMOBILE WORKS

RALPH E. FLANDERS

The subserviency of manufacturing considerations to considerations of strength, durability, accessibility, etc., results in the design of parts for automobiles which require special and interesting provisions for their economical production. Only a few of the operations particularly noticed in the factory of the Stevens-Duryea Co., Chicopee Falls, Mass., will be described here. They will serve, however, to give an idea of the general practice in such work, and will illustrate the ingenuity required for the solution of some of the problems.

Operations in the Machining of Cylinders

In Fig. 1 is shown a Beaman & Smith combined horizontal and vertical milling machine engaged in surfacing the base,

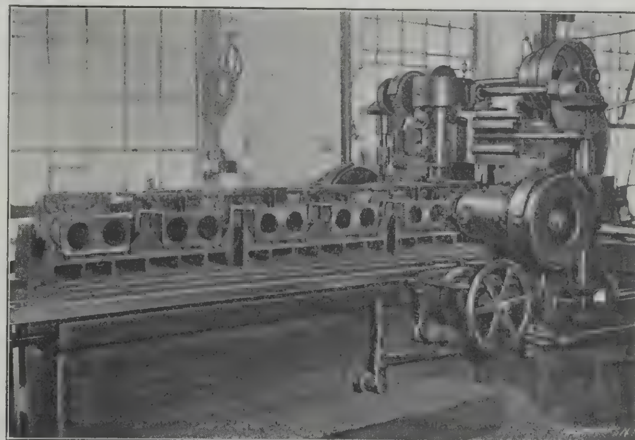

Fig 1. Gang Milling Operation. Surfacing Cylinder Sides and Ends

exhaust and inlet flanges, and the spark plug bosses of a series of cylinder castings. The work is mounted in gangs according to the most approved methods. The picture is chiefly interesting in that it shows that the builders take advantage of wholesale manufacturing methods even in the building of a $4,000 machine. Of course, an extensive use of jigs and fixtures, besides reducing the cost of manufacture, results in a greater uniformity in the product and thus gives the advantage of an easy renewal of worn or damaged parts.

Fig. 2 shows a Beaman & Smith boring machine of a type we have illustrated and described in these columns. Fixtures mounted on the rotating table give provision for holding four double-cylinder castings. This table can be rotated and ad-

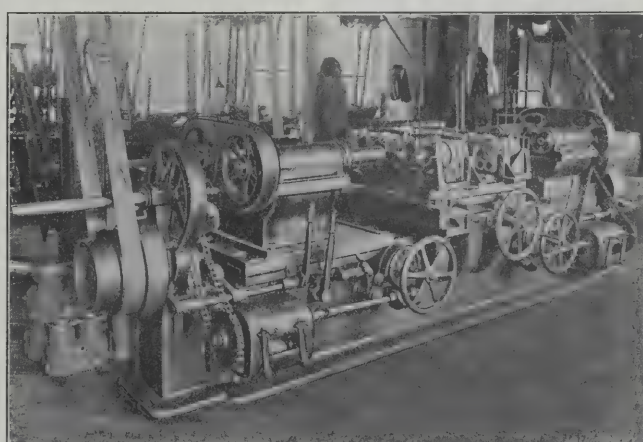

Fig. 2. Four-cylinder Boring Machine with Revolving Table

justed across the bed of the machine. On each side of the table, double boring heads may be fed in along the bed, one carrying roughing and the other finishing cutters, the feeds and speeds of the two heads being independent. A set of two castings being in place on the roughing end, the head is fed into them and one hole in each casting is roughed out. The work-table is then shifted, by means of the hand-wheel, against suitable stops and the other bore of each cylinder is roughed. The table is then indexed to bring these castings to the finishing side, where the same operation is repeated, the boring being here carried to size for grinding. This rotating of the table, in turn, brings a new set of the cylinders up to be rough-

bored. The process is continuous, the work being removed from the finishing side and new cylinders clamped in, while the rough boring is being completed.

For setting out the cutters in the boring bars, a construction is used which is similar to Fig. 16 of the Data Sheet of the May, 1909, issue of MACHINERY, except that a taper screw is used for forcing the blades out simultaneously. This is shown in Fig. 3 at the left. The cutters *B* bottom on this taper-headed screw *C*; filister head screws *D* serve to keep the blades forced down to their bearing on *C*, and so draw them firmly against the side of the slot. By this means two or more blades may be set out simultaneously for regrinding to exact size. A similar arrangement (see view at the right of Fig. 3) is used for cutters in the middle of long boring bars, except that the taper point of a screw tapped into the bar from the side, is used in place of the corresponding taper-headed screw in the first case.

The bore of these cylinders is finished in Heald internal grinding machines especially built for this work. These are

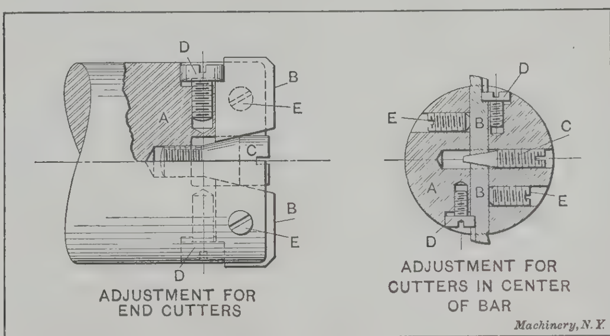

Fig. 3. Adjustment used for Boring-bar Blades

of the type in which the work remains stationary while the axis of the spindle is revolved about the center line of the bore and parallel with it, on such a diameter as to bring the outer periphery of the wheel in contact with the inner surface of the bore. The grinding spindle is fed out so as to rotate in a larger circle as the diameter of the bore is increased. An interesting feature shown in Fig. 4 is the provision of a flexible suction tube for drawing out the dust of the grinding through the inlet and exhaust ports, and also the provision made for water cooling. The water is not applied directly to the wheel, as in an ordinary external grinder, but is forced

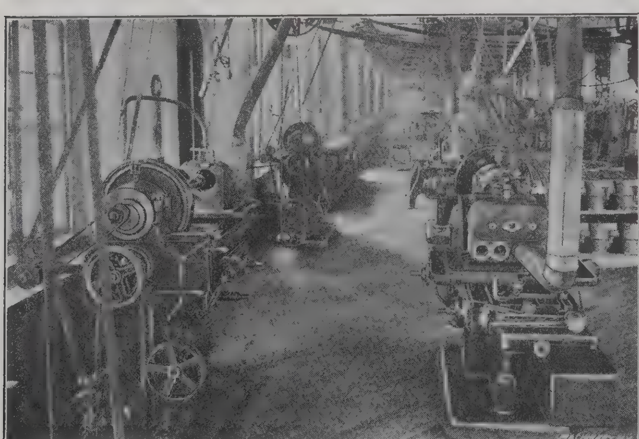

Fig. 4. Grinding the Cylinders. Note Connections for Exhausting the Dust and the Use of the Water Jacket for Cooling

instead through the regular water jacket of the cylinder casting. This reproduces, in a measure, the conditions met with in actual use, and so tends toward accurate work.

Machines and Fixtures for Grinding and Lapping

There are other operations of interest in the grinding department besides that of finishing the bore of the cylinders. Extensive use is made of the Pratt & Whitney face grinding machine for finishing flat surfaces; in fact, it has largely displaced the vertical milling machine for this work, on parts in which the surface to be finished is clear of projections or obstructions to the sweep of the wheel. The faces of the various casings, covers, inlet and exhaust pipes, etc., are finished on this machine. At the time of the writer's visit, most of these parts were still being made from castings on which 3/16 inch of stock had been left, in accordance with the usual practice of milling. The castings come true enough to shape, however, to permit this finish being reduced to 1/16 of an inch, or thereabout, thus materially reducing the time required.

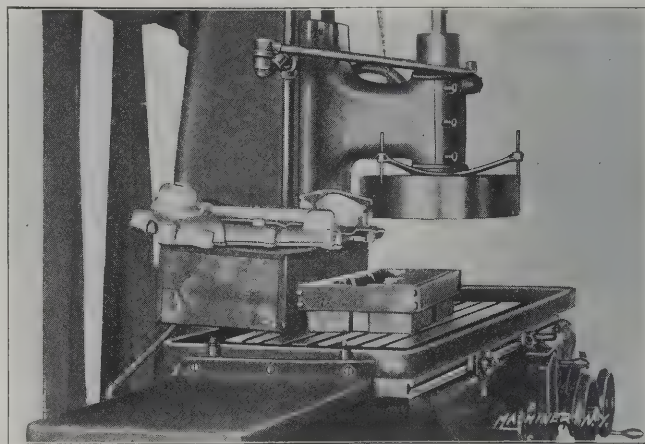

Fig. 5. The Acme of Simplicity in Fixture Making. Face Grinding the Steering Gear Casing

Even when removing 3/16 inch of stock the grinding machine has proved its superiority to the milling machine in the matters of cost, finish and accuracy. The foreman of the grinding department discovered that a little experimenting and investigating along the line of the grading of wheels made a tremendous difference in their durability and effectiveness in removing metal. For aluminum work a Vitrified

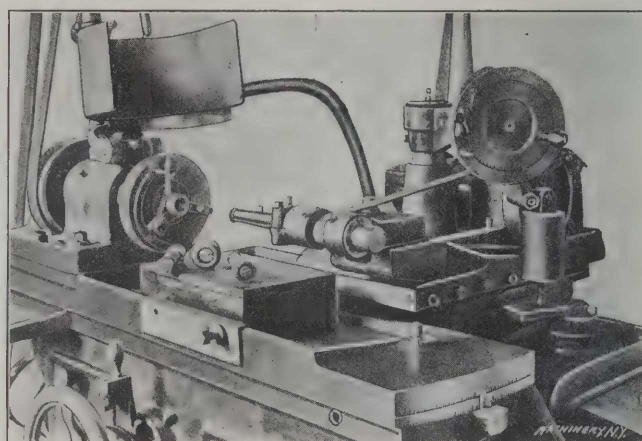

Fig. 6. Grinding the Bore of the Cams Concentric with the Cylindrical Surface

carborundum wheel of about No. 24 grain and grade H hardness is used, a soda compound being employed for cooling.

The cover side of the steering gear casing is one of the parts surfaced on the face grinder. A ridiculously simple fixture is used for holding it. This fixture, as may be seen in Fig. 5, is nothing more or less than a mass of lead melted and poured around a sample casting as a form. The work is set into the bed, thus prepared to receive it, and is supported on the table by its own weight, no fastening being necessary. The castings come uniformly enough so that they fit well in this device, except at certain points around the gates and sprues, where it is found necessary to relieve the form slightly to allow for these variations. It may be mentioned that the other or main member of the steering gear casing has a boss projecting above the finished surface of the joint, making it necessary to mill that surface. The joint is thus formed of one ground and one milled surface.

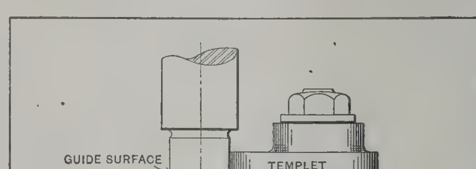

Fig. 7. The Simplest and Stiffest Arrangement for Cam Cutting

In Fig. 6 is shown the operation of grinding the holes in the cams. It is quite important that the cylindrical portion of the cam shall be exactly concentric with the cam-shaft to prevent shock or jar during the period when the valves are supposed to be closed. To make sure that this surface is concentric, the cam is located by it in the grinding fixture as shown. After the fixture has been mounted on the faceplate of the machine, the gripping surfaces of the two jaws at the

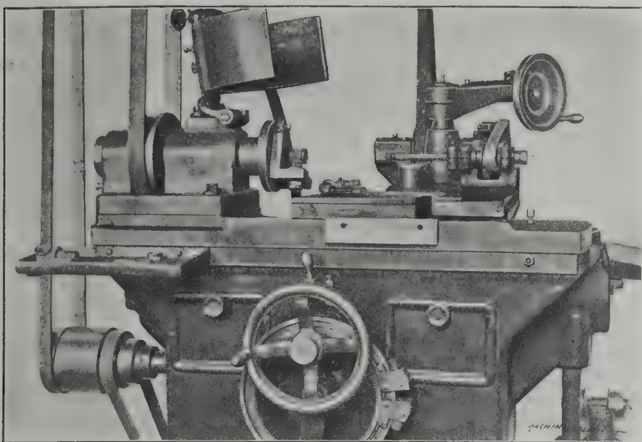

Fig. 8. Grinding the Holes in the Universal Joint Pivots

right are ground out by the internal grinding attachment, to the radius of the cylindrical dwell of the cam. The cam is clamped against the surface thus prepared, by the lever, which forces a wedge across and down upon the cam, holding it firmly into the corner in both directions.

It will be seen that this car does not employ the integral cam-shaft. By giving careful attention to the locating of the cams on the shaft and by being careful to obtain a strong drive fit between them, the difficulties of loosening and dislocation, which the integral construction is expected to cure, have been avoided. It is thus permitted to cut the cams in a way which gives the best chance for producing accurate shapes and smooth finish. The obvious scheme shown in the sketch,

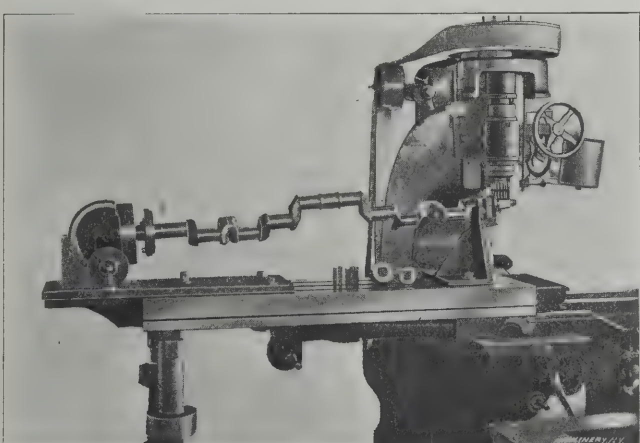

Fig. 9. A Vertical Milling Machine set up for Milling the Tapered Square Drive on the Crank-shaft

Fig. 7, is followed, the operation being performed on a profile machine. The connection between the forming cam and the work is so close that the difficulties of springing and chattering, met with in the construction of the more elaborate machines required for integral cam-shaft, are avoided.

Another faceplate fixture for internal grinding is shown in Fig. 8, where it is employed for grinding the hole in the hardened nickel steel sockets used for the universal joints (see Fig. 7, previous article). The socket is held in the same way as when in use, by a nut screwed onto its threaded shank. It is also located in the same way, a pin in the fixture engaging a slot in the flange as shown. A limit of 0.0005 inch only is permitted in this operation, and an allowance of about 0.003 inch for the depth of the hole is the maximum, just enough being permitted for proper lubrication by the grease supply provided. This fixture is kept in place on the machine practically throughout the season. If at any time it is necessary to remove it, however, it can again be trued up by clamping a model socket in place, inserting a plug in the ground hole, and truing up the plug. These studs are held in the same way in the screw machine for roughing out the hole preparatory to grinding. The form of internal grinding spindle used should be noted. One of them is shown detached in Fig. 6, lying on the table of the machine. These spindles and their bearings are self-contained, interchangeable and adapted to work in holes of various sizes. The clutch drive provided rotates the spindle without side pressure on the bearings.

Machining the Members of the Squared Drive

As previously mentioned, the use of keys is tabooed in the drive of the Stevens-Duryea machine, their place being taken by square sockets throughout. A tapered square drive is used to connect the crank-shaft with the driving member of the clutch. The method of machining this is shown in Fig. 9. It has been found advisable to keep the milling machine set up for this work, continuously, owing to the difficulty of making a good taper square fit. When the machine has once been set it is kept so throughout the season. An ordinary dividing head is used, as shown, tipped up to the angle of the taper. To the face-plate of this dividing head is clamped the fly-wheel flange of the crank-shaft. The outer end of the crank-shaft is supported in a suitable steady-rest as shown. For shorter lengths of crank, filling pieces are employed, having flanges

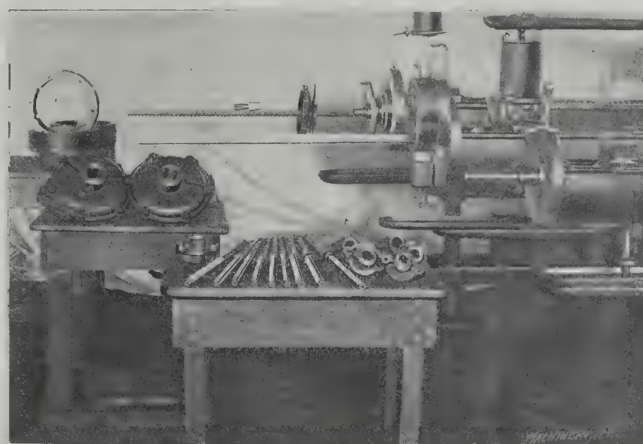

Fig. 10. A Set of Interesting Broaching Operations

bolted to the face-plate at one end, and to the work at the other. The use of filling pieces permits machining of the full line of crank-shafts without disturbing the adjustments.

The automatic cross-feed is employed in feeding the work past the end mill in the vertical milling attachment. The table has to be so far overhung that an out-board support is provided as shown, which permits this cross-feed. This consists of a sliding guide, supported by two standards, reaching to the floor and provided with jack screw adjustments for careful leveling.

The squared holes of the drive are finished on a La Pointe broaching machine in the usual manner. The further machine shown in Fig. 10 is engaged in finishing taper square holes

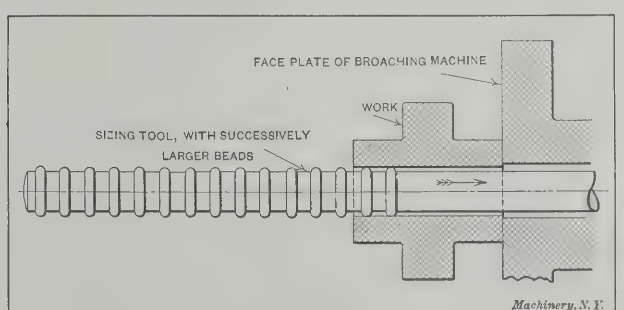

Fig. 11. Method of Sizing Phosphor-bronze in the Broaching Machine by Compression

in the clutch driving flange, this being the member into which the taper squared end of the crank-shaft shown in Fig. 9 fits. The hole is first reamed out to a taper a little larger than the distance across the flat of the finished hole. The work is then mounted on a broaching machine on the fixture shown in place. As may be seen, the broach cuts one corner of the square hole, and one-half way up each of the two adjacent sides, into the relief formed by the taper hole. A dog is fastened to the hub of the work, and the latter is mounted

on a taper plug fitting the hole, with the tail of the dog located by a pin in the face-plate of the fixture, the latter being mounted on the face-plate of the machine at an angle as shown, to agree with the angle of the corner of the tapered sides. This broaching operation was described in October, 1908, page 151.

One pass of the broach finishes one corner of the tapered hole. The broach is then returned to the starting position, the work is drawn off the taper plug, the dog indexed to the second pin on the face-plate, the work is put in position and the second corner broached. This operation is repeated until the four corners have been machined, and the square hole finished, the work being centered on the taper plug of the fixture throughout the whole operation. A taper square gage is shown lying on top of the broach in the engraving. This is used for testing the fit of the holes and the accuracy of the work, and a most accurate fit is made on this by no means easy operation. In the machine in the foreground, another operation is being done—that of broaching the driving slots in the driving clutch members for the multiple disks.

the sizing tool in the broaching machine, it will be found that the hole will be somewhat larger in the large diameter of the work than in the hubs. It has been found that this difference in size can be practically avoided by passing the sizing tool through the work three or four times. Few pieces of this kind are found, however. The operation is a rapid one as compared with reaming.

An Adaptable Lapping Machine

The machine shown in Fig. 12 was built mainly in the factory, use being made, however, of the adjustable columns of a Taylor & Fenn sensitive drill press. This special machine is intended for lapping out the square holes of the drive, but is provided also with a rotary movement in addition to the vertical movement thus necessary, so as to provide for cylindrical lapping as well. The driving pulley at the right gives the reciprocating motion, while the pulley at the left rotates the spindles through the medium of the regular geared speed drive. The sprocket wheels shown, driven from the right, are loose on the driving shaft, and carry eccentrics whose rods are extended to form racks engaging, through a

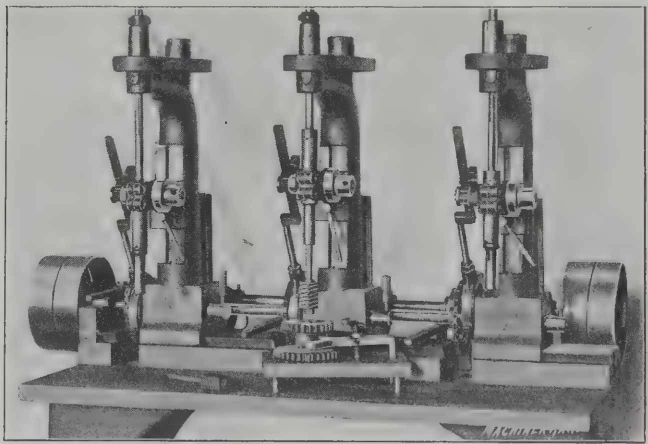

Fig. 12. Machine for Circular and Square Lapping Operations

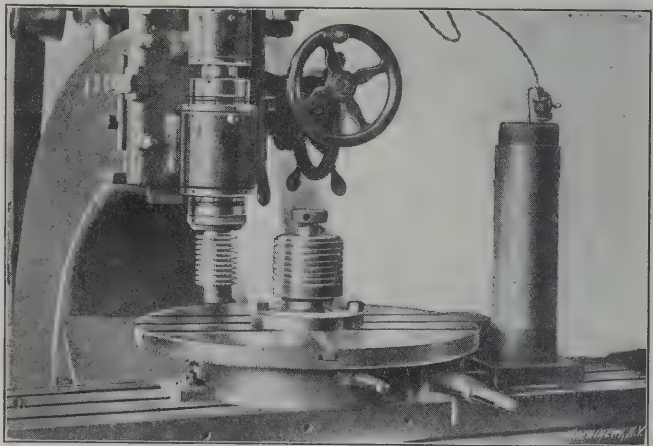

Fig. 13. Cutting out Piston Rings in the Vertical Milling Machine

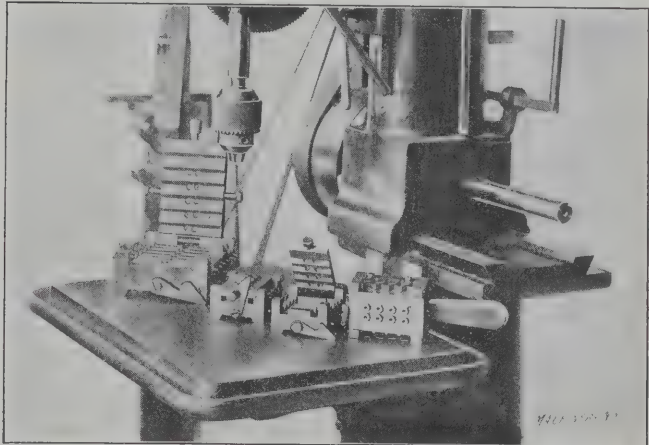

Fig. 14. Interesting Drill Jigs for a Simple Operation

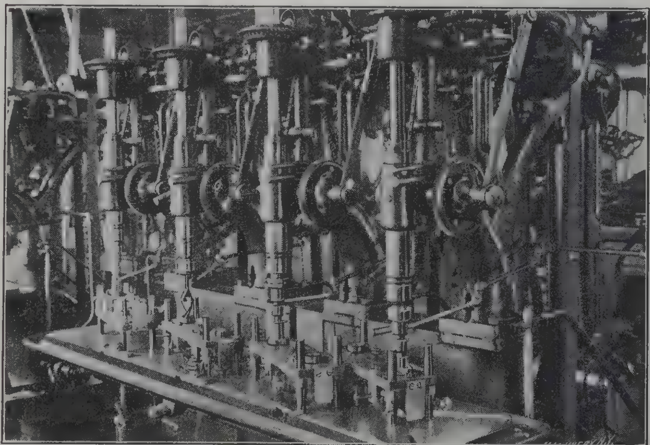

Fig. 15. Gang Drill used in Drilling and Reaming Connecting-rod Ends

Sizing Round Holes in the Broaching Machine

Another unusual operation for which the broaching machine is here used, is that of sizing holes in hard phosphor bronze bushings. This material, as any mechanic who has had any experience with it knows, is as hard on a finishing reamer as anything well can be. It is tough, elastic and slippery, and the less there is to ream the more difficult becomes the operation. Instead of reaming such holes, the tools shown in Fig. 11 are used in this shop. It will at once be seen that the operation is that of compressing the metal in the sides of the hole, until it has been enlarged to the finished size. The tool is drawn through the work. Each of the rounded rings or beads is a little larger than its predecessor, thus gradually compressing the metal the desired amount. The finished hole springs to a size smaller by some few thousandths than the diameter of the largest ring on the tool, so that the size of the latter has to be determined by experiment. This allowance varies slightly also, as may be imagined, with the thickness of the wall of metal being pressed. In such a part as that shown in Fig. 11, for instance, after drawing through

suitable clutch connection, the pinion shafts by which the spindle quills are fed up and down. It is thus possible to give a rotating and reciprocating movement to the spindles, either together or separately.

Separating Piston Rings

Another milling operation is shown in Fig. 13. It is a common practice to make piston rings on an automatic machine specially rigged up for the purpose, separating the rings from the finished casting by means of a series of parting or cutting-off tools, each of which is set a little in advance of the other so that the rings will cut off in regular succession. The parting tool, however, especially when used in severing cast iron work like this, having an eccentric bore, leaves a considerable burr. In the method of severing the rings shown here, the eccentric cylinder is first finished complete on the turret machine. Then it is mounted on an internal expansion chuck on the face-plate of the cylindrical attachment of the Becker vertical milling machine, as shown. This chuck is provided with clearance grooves for the gang of saws shown in the engraving. These are sunk into the cylinder, and then the

work is rapidly revolved, cutting out the eight rings at once. The saws are permanently mounted on their arbor, with separating collars ground to the proper thickness.

Examples of Fixtures used for Drill Press Operations

The drilling department seemed unusually small, when compared with the size of the whole plant, and gave the appearance of being worked at high pressure. The large output required was evidently maintained by the universal use of highly developed jigs for all manufacturing operations. Multiple spindle drill presses are used to almost the entire exclusion of the single spindle type.

Fig. 14 is interesting as showing the development in the jig for a comparatively simple operation—that of drilling the cotter pin hole in a headed cylindrical stud. In the first apparatus employed (not shown) the stud was pushed into a hole up to its head, and held there by a lever, one piece being done at a time. This rigging had two faults. One piece at a time is held, and trouble with chips and burrs was experienced, as might be imagined. An improvement on this device is shown in the two jigs at the right, where a base with a set of V's is provided in which several of the pins may be placed, their heads being pressed up against the end of the V-block by springs. The cover being clamped down on the work, the parts are thus held for the drilling operation. This, however, was not quite easy enough to clean to suit the ideas of the tool designer, so the fixture shown at the left was used for the next tool of this kind that had to be made. Here hinged sides are used instead of springs as in the previous case. These sides fold up and press the heads of the work against the edges of the V-block. When they are turned down and the cover of the V-block is raised, the top surface of the V-block is all clear, so that the presence of chips shows inexcusable carelessness on the part of the operator. When the sides are folded up against the work and the cover is brought down, the latter, by means of wedge surfaces, presses the sides in, holding the heads of the work firmly in place and clamping them down on the V-block at the same time.

Fig. 16. An Unusual Array of Automatic Chucking Machines; Thirty-one are used in this Department.

Fig. 17. The Engine Assembling Department

The jig shown at work in Fig. 15 is used for drilling and reaming the connecting-rod holes. It is of the "four-legged table" variety, with suitable clamps and hook bolts for taking the strain of the cut without permitting noticeable deflection and consequent inaccuracy in the work. A feature of the construction which is probably old enough, but was new to the writer, is the provision made for both drilling and reaming with a fixed bushing, thus avoiding the use of slip bushings of different diameters. For drilling, the jig is used as shown in the engraving, with the work clamped beneath the plate and the jig bushings above, guiding the drills. For reaming, the jig is reversed and a reamer is used having a pilot, which passes through the work into the jig bushing (now on the under side of the plate) by which it is guided.

Fig. 16 shows what is by long odds the largest aggregation of automatic chucking machines the writer has ever seen. There are thirty-one of the Potter & Johnston type. Practically every turned part not made in the screw machine from the bar is produced on these machines. That old standby, the engine lathe, appears to be about the rarest machine tool in the shop.

Fig. 17 shows a section of the engine assembling room. It will be noted that machine tools are few and far between, the only ones in sight being a drill press, speed lathe, and two or three grinding stands for sharpening tools. This shows that the manufacturing operations have been performed with great exactness. The question of assembly is simply one of bolting and screwing the separate parts together. The engines here shown are of the four- and six-cylinder type. The overhead trolley lines should be noted.

One of the most interesting departments in this factory is that for testing the completed engines. This, however, deserves an article by itself, and will be so treated in a future issue.

* * *

AN EARLY DEVELOPMENT OF INTERCHANGEABLE MANUFACTURING

An interesting feature of trading and manufacturing in Siberia, also common in European Russia, is mentioned in an article on Siberia in the September issue of *Cassiers' Magazine*. The system is referred to as the "Artel" system. The Artels are combinations of artisans, representing individual occupations and handicrafts, and are especially common in village communities. They are cooperative associations, the work being parceled out among the members and the profits on the work being divided among them in accordance with the rules of the Artel. The members carry on their work in their own cottages, much of the work being done in the winter time during the season when there is no work required for cultivating of the land. One common industry is that of making winnowing machines used by farmers for separating the grain from the chaff after threshing. These are sold in thousands, and are manufactured both in Russia and Siberia by these peasant associations. The machines are very satisfactory for their purpose, and are sold at an extremely low price, due to the system of manufacture followed by the Artels. Each man has a special part of the machine to make, and is provided with a templet for its making. The parts are produced in lots of hundreds and are brought together from the various workers and assembled by another group of workmen who have specialized in this part of the work. This system is exactly the same as that known to modern industries as the interchangeable plan of manufacturing, but it has been in vogue in Russia in the form just described long before it was thought of elsewhere. The trade in this particular machine is so enormous that more than one firm manufacturing agricultural machinery has endeavored to secure a portion of the business, but so far all have failed because no one has been able to produce and sell the machines at the price at which the Artels are able to sell them. Of course, it is only the very simplest machines that can thus be made by the Artels, and they are not able to extend their operations in directions where a higher degree of skill is required, but it is nevertheless interesting to note that the underlying principle of modern shop practice has been applied to the very crudest form of manufacture in countries usually considered so far removed from industrial progress as Russia and Siberia. The recognition and application of the principle are the important facts

A CHAPTER IN THE EARLY HISTORY OF MACHINE TOOLS

JOSEPH G. HORNER*

In the lathe we see the earliest developments of machine tools, not only as the lathe and its allied forms are concerned, but because of the influence which this tool has had in the evolution of other types. The mandrel and its bearings occur in other machines, and the self-acting slide and tool-holder also, as well as many of the smaller details—lead screw,

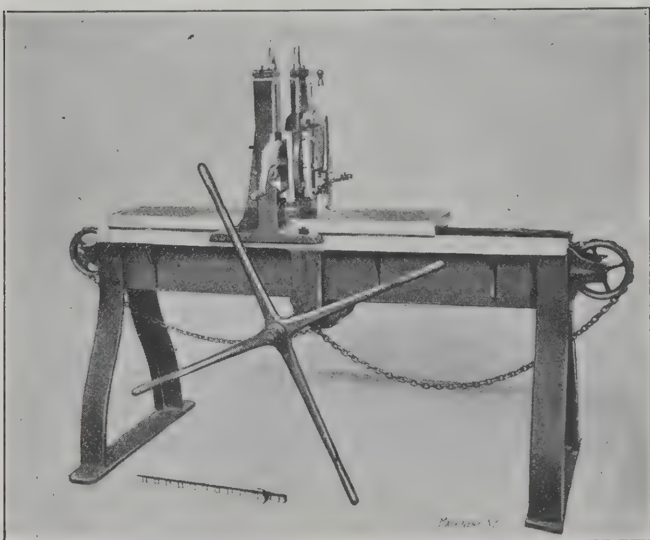

Fig. 1. Roberts Planing Machine, Table 52 inches Long by 11 inches Wide (1817), South Kensington Museum

change gears, feed rods, methods of take-up, and so forth. The lathe preceded all other tools and influenced their design.

Planing Machines

After the slide-rest had become developed into a traveling element the principle was not long in being applied to other

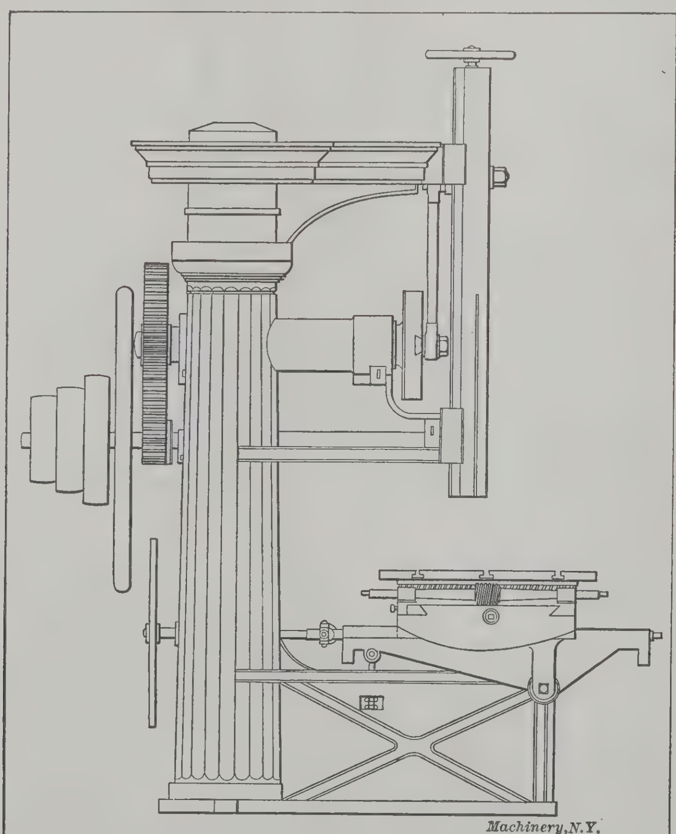

Fig. 2. Self-acting Slotting Machine, Caird & Co., Greenock (about 1846)

machines. First came the planing machine, pioneer of a long line of machines, the principal value of which is due to the coercion exercised on the tool by the sliding action. The honor of its invention appears to lie between four claimants, Roberts, Clements, Fox, and Murray, working during the period of about 1814-1820. This was a very prolific epoch in the history of machine tools; an age of great inventors, pupils, and followers of Bramah and Maudslay.

The planing machine by Richard Roberts of Manchester, now in the South Kensington Museum, Fig. 1, still bears evidence of the hand work done in fitting it up. It is chain-driven, the chain passing round a drum underneath, about the center, going thence over guide pulleys at each end, and attached to each end of the bed. The movements were operated by the large cross handle seen on the axis of the drum. The bed is cast in two parts, of angle section, bracketed and bolted to the legs. Its top edges are inverted vees, doubtless made thus with the intention of preventing lodgment of the chips.

The upper work is remarkable from the fact that the tool-holder is nearly as large as the standards. These are castings slotted on the front for the clamping of the cross-slide. This is elevated by means of independent screws. The tool-slide is traversed by a feed screw.

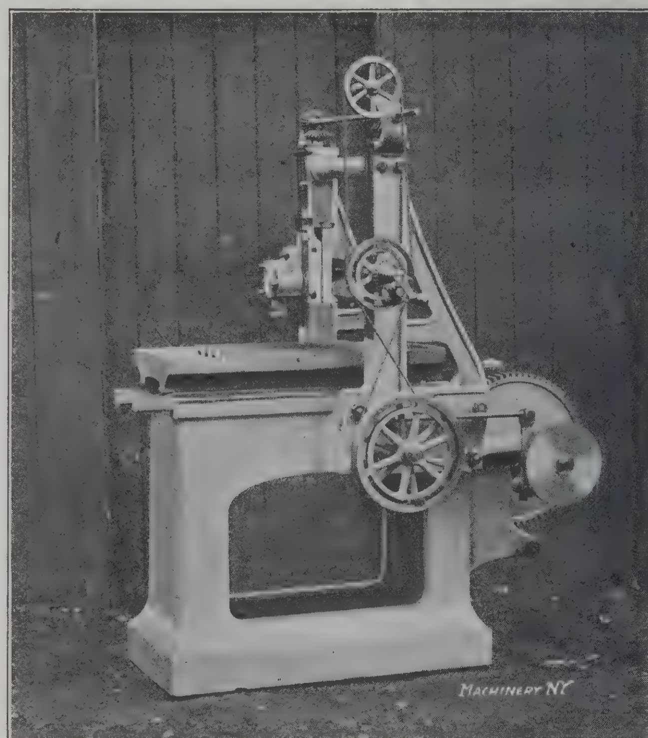

Fig. 3. Whitworth Crank-driven Planer (1868)

During the decade 1830-1840 the demand for high-class machine tools became pressing and extensive, due largely to railway developments. The firm of Sharp, Roberts & Co. was one of the earliest in the field. It had been in existence since 1828, having been engaged in the construction of cotton spinning machinery in Manchester. Roberts was the inventor of the firm, and he designed many lathes, machines for planing, slotting, the cutting of wheel teeth, punching and shearing. Roberts is credited with having invented the system of templets and gages to secure interchangeability of parts in locomotives. This last would be subsequent to 1834, when Sharp, Roberts & Co. started the Atlas Works.

Whitworth stands out a giant among the giants of the time, and his work has eclipsed in poular estimation that of most of his compeers. The period of his activities is marked by numerous improvements and inventions. But the three which have left the most lasting results are the standardization of screw threads, the method of production of a true plane, and measurement by micrometer instruments and by fixed gages. These were the advances which rendered accurate mechanical construction possible. They have been largely instrumental in the displacement of hand work in the construction of machines. They were the incentives to later developments, and they have in some degree dwarfed Whitworth's work in the improved designs of machine tools, or perhaps less attention has been attracted to these. But these are nevertheless very prolific and very interesting. His work has stood the test of time so well that most of the inventions and improvements which he devised have never been superseded. Machines, methods of manufacture, standardization,

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measurement, and test, bear the impress of his genius; and the great firm which he founded still fully maintains the old traditions and high reputation of its originator.

Whitworth seems to have been the first to design that form of planer in which the work remains stationary while the tool travels. He had patented a machine of this kind in

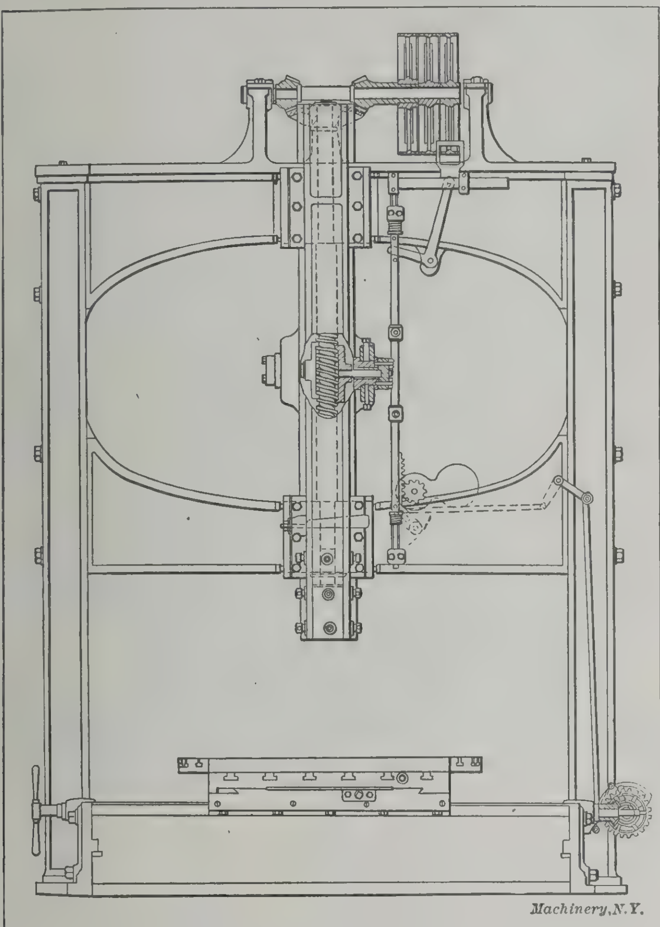

Fig. 4. Slotting Machine, Screw-driven. Front Elevation. Joseph Whitworth & Co.

1835, in which the side frames carrying the cross-rail traveled on large wheels on rails low down on each side of the fixed work table.

This Whitworth planer of 1835 was very skeleton-like, if judged by our standards, as indeed all the early tools were; but the resemblances to some features of present-day machines are striking. The lightness of build is illustrated by the fact that flanges were cast on the outside of the framing, and flanges on the traveling heads came just underneath them, with the object of preventing the traveling mechanism from tipping under heavy duty!

Being a traveling head machine, provision was made by three sets of flanges forming ledges within the cheeks for receiving the work tables at three different heights. The cross-rail was elevated by vertical screws and bevel gears, and the cross-slide could be bolted at any height on the face of the uprights.

The crude beginning of the screw worm drive which Whitworth subsequently used on the planers and drilling machines may be traced to this early machine. Two square-threaded screws ran alongside, one flanking each upright and reversing the travel at equal rates. The two side screws were driven from bevel wheels, the transverse shaft having three reversing bevel wheels with claw clutches at the center. Curious recessed rollers were used to transmit the motion of the screw to the uprights, the edges of the rollers, which were set at any angle, entering into the thread spaces. From this device the worm-wheel engagement would naturally follow in time, as it did.

This machine embodied also the reversible tool-box in a crude form, but reversed similarly to later ones by means of a cord round a pulley. The pulley was not in the axis of the rotating box, but on a spindle in front, whence the movement was transmitted through spur gears. The down-feed was accomplished through ratchet mechanism acting on a screw at the head of the tool holder.

In 1837 Whitworth modified the tool-box, introducing the cam groove cut on the rotating body, and which when acted on by a pin operated by the vertical movement of the feed rod imparted the rotary movement. This device has remained permanently embodied in the firm's planer tool boxes of this type.

The fitting of two tools in the box to avoid the rotation of the holder was patented by John Roberts in 1838. In its essentials it is like double cutting holders of to-day, the box being pivoted to throw off the tool which is not in action.

The design of planing machine which has come into considerable prominence lately, in which the tool is reciprocated instead of the work, was being worked out about 1840 by M. Decostre, of Paris, M. Cave and Mr. Hick of Bolton. The first was chain operated, the second by means of a leather belt, the third by a steel belt. In M. Decostre's machine two endless chains were used running the whole length of the machine. The bed was V-grooved, carrying supports, and a cross-rail with the tool-holder. In the machine of M. Cave an endless belt ran over fixed and tension pulleys communicating motion through gears to two racks.

The planing machine had been nearly crystallized in its present design in the forties. The method of driving still lay between rack and screw, for Whitworth had then applied the screw drive to both planing and slotting machines. Quick return in rack-driven machines was effected by larger and smaller fast and loose pulleys driving through gears to the rack pinion. There were three designs of racks then. There

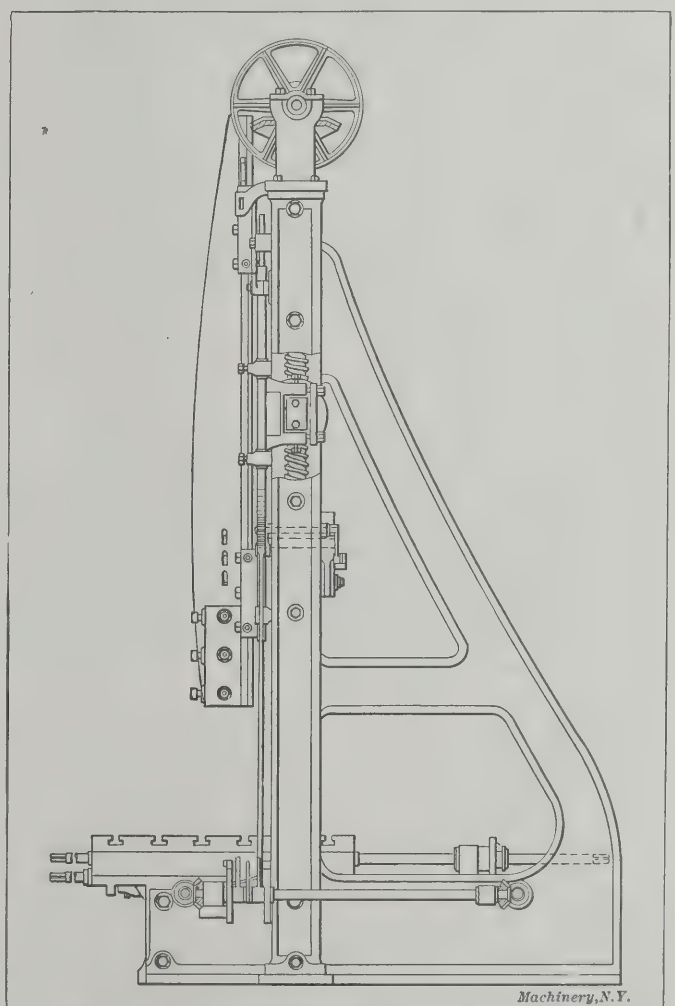

Fig. 5. Early Self-acting Slotting Machine, Screw-driven. Side Elevation. Joseph Whitworth & Co.

was the simple single rack, there were the two racks bolted to the under side of the traveling table with the teeth set to hit-and-miss, and there was the stepped rack with three steps, each step having its teeth equal in length of face to one-third the width of the rack, being set behind its fellow at a distance equal to one-third of the pitch. This was introduced by a Mr. Collier of Manchester.

To the screw reversal the objection was that the return speed was not accelerated, the bevel wheels being of equal sizes. Mr. Shanks of Johnstone modified the gear by placing two bevel wheels of different sizes on the end of the screw, the diameters of which bore the same relation to each other as the speeds of cutting and reverse did. These were operated by pinions on solid and hollow shafts, and the device has been fitted to many machines.

The earliest Whitworth screw did not engage with nuts as at present, but with worm-wheels, being the same device as the rack worm-wheel applied to the lathe lead screw, but duplicated. Two worm-wheels on opposite sides of the screw, and having their spindle bearings secured to the under side of the table, were revolved by the rotation of the screw, and thus carried the table along. The same method was applied to the spindles of drilling machines. The device was first applied by Whitworth in 1835 for the motion of the carriage of a self-acting spinning mule.

A favorite type of small planing machine in and around the Manchester district is the crank-driven design. One of these of date of 1868 by Whitworth & Co. is shown in Fig. 3. It is driven by a cone pulley through crank-pin and slotted link, adjustable for stroke, and giving quick return. The

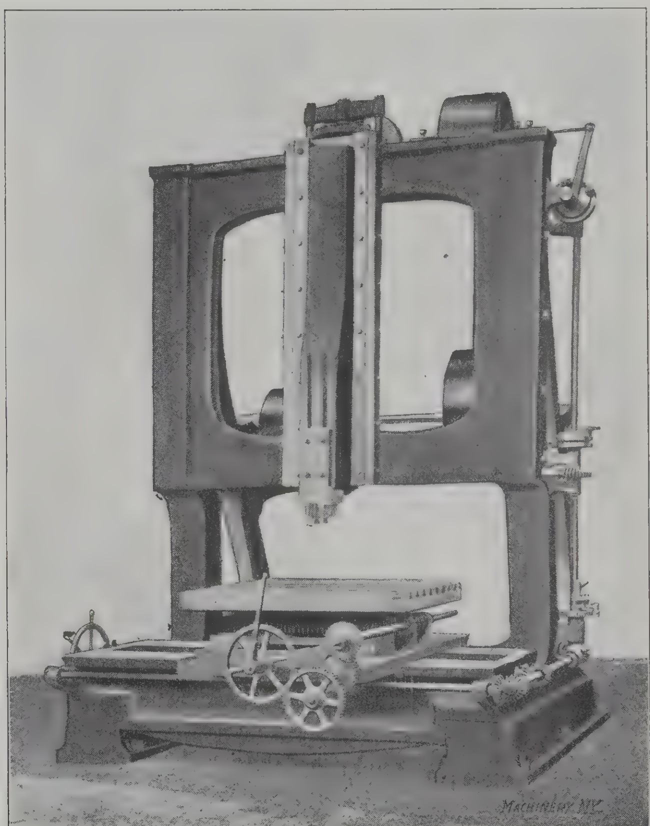

Fig. 6. Slotting Machine. Joseph Whitworth & Co. (1874)

slotted link is provided with a connecting-rod, one end of which is attached to the table. The feed is operated from an edge cam keyed to the crankshaft. This rotates at each end of the stroke through bevel gears the cord pulley at the bottom of the upright. The cord fixed to this pulley passes round the several pulleys shown, and gives a variable horizontal feed by means of the ratchet gear on the end of the cross-slide, and a variable vertical and angular feed by ratchet gear on top of the tool slide.

At an early period the American planing machines were improved and developed on different lines from the English ones. Some of the early chain machines remained in use in England, and in the States as late as about 1880, side by side with many of the improved forms which are even now regarded as modern. The Sellers' drive was then in existence —the spiral pinion working diagonally in its rack, an improved form of Bodmer's worm and rack. The rack-and-pinion drive was also in use. The plain rack and the stepped rack divided favor in England, but the pinion was always small, with a tendency to lift the table. The large driving or bull wheel was early adopted in America. The single belt for driving and reversing was early abandoned in America for two belts, one driving, the other for reversing; and high speeds and narrow belts also were adopted, and the shifting of one belt at a time. The feed gear was operated from the driving gears instead of by tappets on the table.

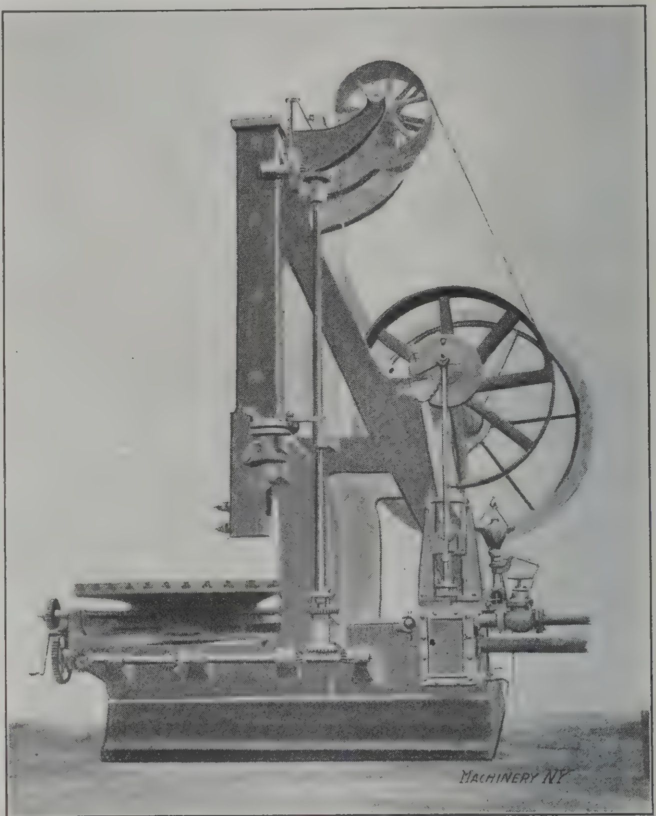

Fig. 7. Slotter driven by Steam Engine. Joseph Whitworth & Co. (1867)

Mr. Richards has a hit in an old pamphlet at the ornamentation which was a common feature in early machine tools. He said "The strains that fall upon the standards of planing machines are so obvious that there should be no difficulty in determining the best form; but these standards offer so inviting a field for architectural ornament that only a few tool makers forbear adding some filigree work. The beads, moldings, and ornaments of cast-iron machine parts were long ago discarded by the better class of engineers, and are at present seldom seen except in New England or in France.

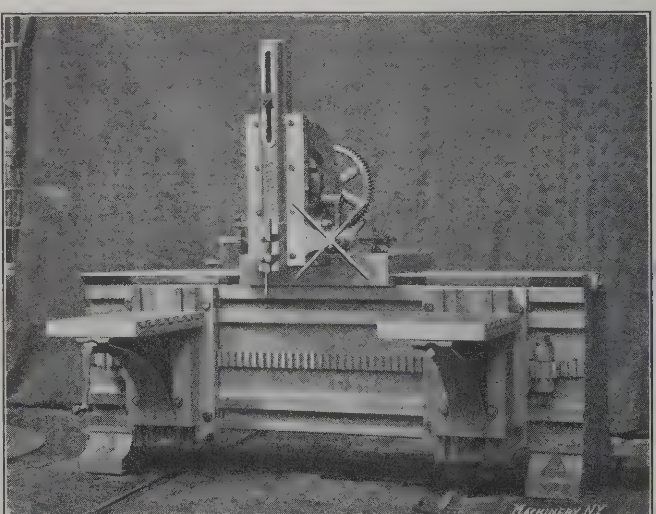

Fig. 8. Special Slotting Machine with Lateral Feed. Joseph Whitworth & Co. (1865)

As a rule the want of good fitting and want of true proportions in machine tools is directly in proportion to the amount of attempted ornament."

Three large wall planing machines were among the equipment at Soho. The largest covered a wall space of 27 feet by 9 feet. The traversing screw was 4 inches diameter, of ⅝-inch pitch, double threaded, and the nut of 2 feet in length embraced only the upper part of the screw. An interesting feature was the double cutting tool-box of the rocking type

reversed by a trip lever, and it carried four tools, two facing in each direction.

The Richards side planers were first described in a pamphlet printed in Philadelphia in 1882. They are there termed combination, or compound planing machines, because they perform the functions of both planing and shaping machines, and the features there described, now familiar, had the claim of novelty: "The time required to fasten work is not one-half as much as with a common machine. The tools always

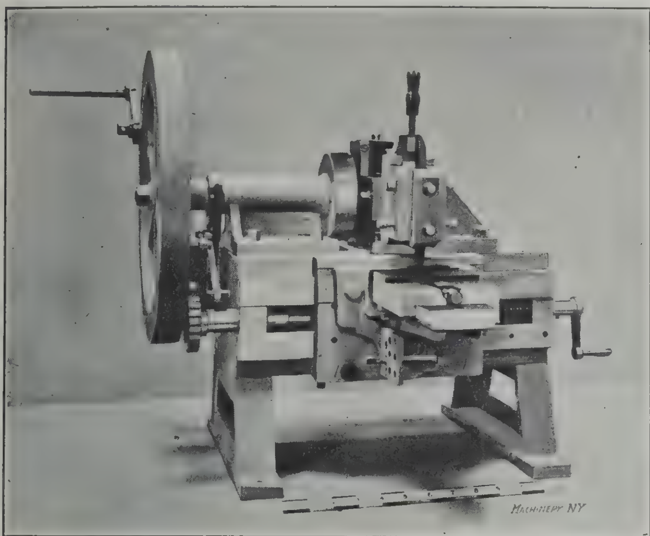

Fig. 9. Shaping Machine designed by James Nasmyth. South Kensington Museum

operate at the same level, and the range of movement is nearly as accurate as with crank motion. The stroke is as complete at 2 inches as at 50 inches." The entire absence of gear wheels is mentioned, and the noiselessness of running. Two sizes of machines only were made at first, one to plane 50 inches by 20 inches, weighing two tons; the other to plane 60 inches by 25 inches, and weighing three and a half tons. Mr. J. Richards, who did so much for machine tool development in America, early advocated the fixed work, and the traveling tool embodied in his side planer. He said in a paper published in San Francisco in 1880: "When work becomes many times as heavy as the implements required to cut it, there are good reasons for moving the tools instead of the piece. The principle is traceable through all machine tool practice of our day, but is especially marked in the case of planing appliances. Mammoth machines with running platens to plane eight, ten, or twelve feet square are now seldom made except in this country. Four feet square may be called an economic limit for moving platen machines. . . . A large sole plate with portable tools for planing and boring is in most cases all that is required."

Slotting Machines

The slotting machine was invented by Richard Roberts, but the idea was borrowed from a machine by Maudslay used for cutting the mortises in ship's blocks. Roberts' machine was in general appearance and design similar to present-day machines, but there was no quick return. Nasmyth, seeing the objection to the limitations in diameter due to the presence of the gap, designed in 1836 a table machine in which the slotting ram was placed below in a pit. The advantages which he claimed were that it was capable of operating upon wheels of any diameter, that it would take a much deeper cut, there being an entire absence of any source of springing or elasticity in its structure, that it operated with more precision, occupied less space, and did not cost above one-third of the other machines. This might be regarded as the prototype of the keyway seating machines.

There was a slotting machine at Soho foundry attached, like so many of the machine tools there, to the wall. The base-plate, with table and slides was on the floor. The ram moved in dovetailed slides, and was driven by a single threaded screw of 4½ inches diameter and 1 inch pitch, the cutting and return movements being effected by a nest of bevel gears at the top of the machine. The screw ran in a nut at the head of the ram, the weight of which was counterbalanced. Power feeds were fitted to the table slides.

The early form of slotting machine was obviously an adaptation of the planer, but crank-driven. Though it had no quick return, and no self-acting table feeds it had the two rectilinear and the circular movements imparted by hand, and a tilting table, and thus marked a very great advance in the methods of the machine shop. An example by Caird & Co., Fig. 2, previous to 1847, is curious for its architectural features, its fluted column, and architrave on the overhanging head.

One of Whitworth's early slotting machines with the ram, screw-driven as previously mentioned, Figs. 4 and 5, avoided the difficulty of the obstruction of the standard by employing two uprights bolted to the base, and leaving a clear space between them from front to back. Two stretchers bolted between the uprights provided the guides for the ram. Fig. 6 is a similar machine of date 1874.

Among the tools at the old Lambeth works was a slotting machine by Sharp, Roberts & Co. of Manchester, bearing date 1840. The framing was arched at the top. A six-stepped belt cone drove the ram through a slotted crank and connecting-rod arranged at the back, but at the side of the main frame which was a very skeleton-like affair. The table was provided with all motions, including the circular, and an elevating motion of its base between the main framing. Feed was self-acting from a cam on the cone shaft. A trunnion fitting to the table provided for taper slotting.

A large Whitworth slotting machine (1867) for general and locomotive work is shown in Fig. 7, driven by a steam engine with governor attached. The stroke was about 4 feet. The tool ram is actuated by means of a quick threaded screw from the drum of the engine crankshaft by shifting belt to top pulleys, thence through bevel gear for the cutting stroke, and miters for quick return. The bottom of the main screw is

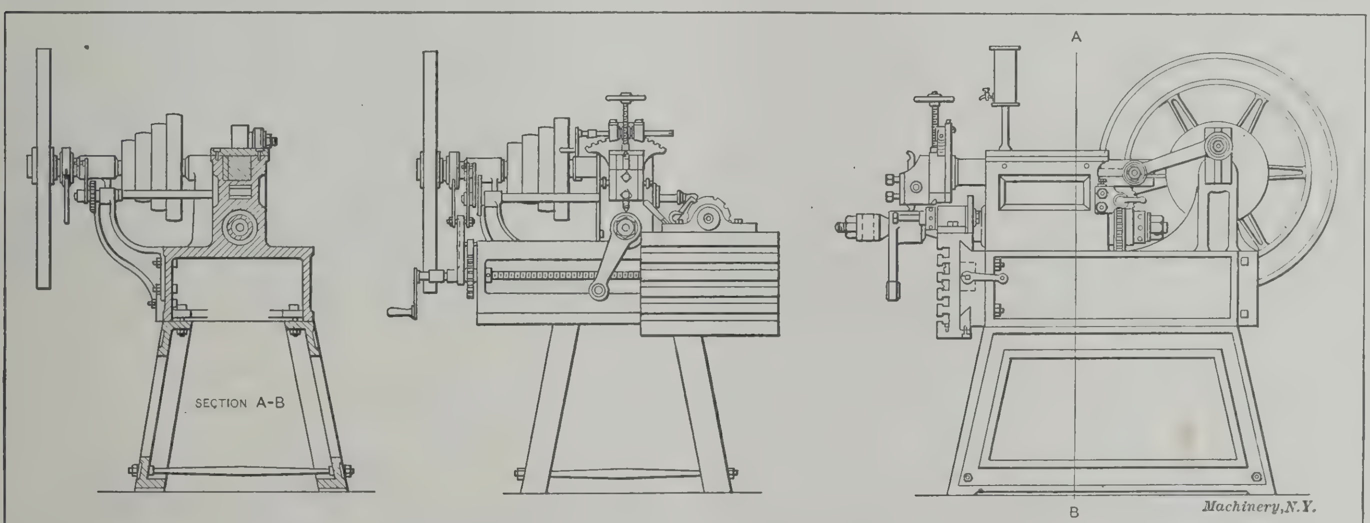

Fig. 10. Compound Planing Machine or Shaper. Nasmyth & Gaskell

fitted with small bevel gears giving motion to a worm and worm wheel which rotates the slotted disk. This is provided with tappets adjustable for length and position of stroke. The tappets actuate the long vertical shaft, the top of which is coupled to the belt striking gear, and the bottom to the variable reversible feed motion in the longitudinal, transverse, and circular directions. The table is 6 feet 6 inches diameter and the distance between the uprights is 8 feet 6 inches.

A Whitworth machine which embodies features of the shaper and slotter is shown in Fig. 8. It was a special slotting machine (1865) made for slotting out the port holes in the cylinders of locomotives, and doing ordinary work on the table of the machine. The tool ram is driven from a balanced counter-shaft by means of the single pulley seen at the back of the head, thence through the spur gears, slotted disk, and connecting-rod, adjustments for length and position of stroke being provided for. The variable feed is operated from an edge cam on the disk shaft through the slotted lever seen on the right-hand side of the head; thence by ratchet wheel, miter wheels, and revolving nut on the screw in the bed, for longitudinal feed; and by the left-hand ratchet gear, miter, and screw, for the transverse feed.

Shaping Machines

Nasmyth invented the shaping machine in 1836 with the object of tooling the smaller details which were not suitable to go on the planing machines. It was known as "Nasmyth's steam arm," of which the arbor for segmental work formed an important element. Said he: "None but those who have had ample opportunities of watching the progress of executing the detail parts of machines can form a correct idea of the great amount of time that is practically wasted and unproductive, even when highly skilled and careful workmen are employed. They have so frequently to stop working in order to examine the work in hand, to use the straightedge, the square, or the calipers, to ascertain whether they are 'working correctly.' During that interval the work is making no progress; and the loss of time on this account is not less than one sixth of the working hours, and sometimes much more; though all this lost time is fully paid for in wages."

An early form of the Nasmyth shaper, hand operated, is in South Kensington, Fig. 9. A somewhat later design, power driven, is illustrated by the drawing Fig. 10. This was termed a compound machine, because it included circular tooling on the mandrel, which did away with a deal of hand chipping and filing on lever ends and similar work. It had no quick return at first. Whitworth was the first to fit that. It was just a short stroke machine substantially like present day successors only of rather bizarre appearance. It was belt-driven on cones, with adjustable stroke and self-acting feed to the arbor.

Yet the original of the shaper may be traced to a machine in Maudslay's shop. Two girders supported on legs carried the sliding work bed, over which the the tool-box was traversed and reciprocated between two round bar guides. These movements were derived from a large cord-driven stepped pulley, crank and connecting-rod, to the tool-box. The latter with its guides could be adjusted vertically by four screwed pillars, with nuts above and below the bosses of the guide bars which fitted over the pillars. An interesting feature is that the tool box was rotated through 180 degrees at the end of each stroke, to cut on each stroke.

* * *

The question of supplying power to Paris by means of an electric generating plant at the Rhone falls now appears to have reached the stage of probability. It is planned to transmit 150,000 kilowatts direct current at a voltage of from 120,000 to 200,000, although there is doubt on the question whether the three-phase system would not be preferable. The capital cost for the whole project is estimated at $20,000,000 and an important factor yet to be decided is whether it will be possible to deliver current at the capital at lower cost than when generating locally by steam. It is, however, probable that manufacturing towns would grow up around the falls, similarly as has been the case around Niagara, and in this case the project of establishing a large power station would be entirely feasible.

BEAM CALIPER FOR WHEEL WORK

WALTER DE SANNO*

While running a wheel lathe, I designed the caliper shown in Fig. 1. While this tool was intended for wheel work, it is also useful for general work when made in smaller sizes. The steel beam of the caliper is provided with one-inch graduations for about one-third its length. A sliding scale *A* is used to give fractional measurements. Fitted to the beam are two arms *B* and *C*. The arm *C* is fixed while *B* is movable. Fitted in the ends of these arms are tool steel pieces *D*, which are hardened and ground to size. The length of each of these pieces is exactly 4 inches. For driving wheel work the arms *B* and *C* should be about 10 inches long, and made light and strong. The sliding scale, which fits in a groove

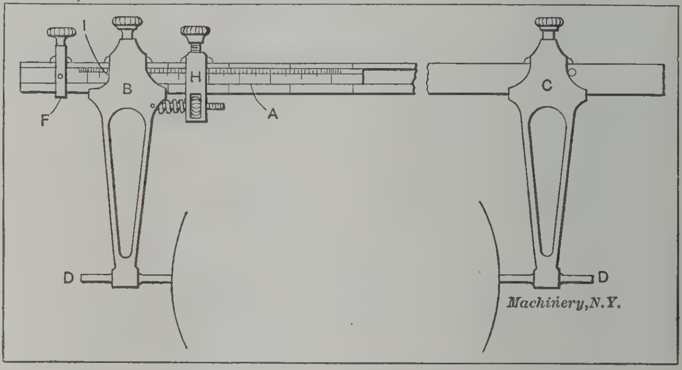

Fig. 1. Beam Caliper for Inside and Outside Measurements

in the beam, is attached to the movable head *F*. This scale is graduated in thirty-seconds, and for a distance of ⅛ inch on either side of the two extreme inch marks, the graduations are in hundredths. The head *H* holds a knurled nut, by means of which fine adjustments are made.

To illustrate the method of using this caliper we will assume that the largest wheel in the set has been measured preparatory to turning. The sliding scale is then adjusted until the first inch mark coincides with the edge *I* of head *B*, which edge is used for all measurements. The scale is secured in this position, and the smallest wheels in the set are found. These are generally the main wheels. The sliding scale shows the difference in size between the largest and smallest wheel, and it is also useful in showing just what the reduction is when turning. By measuring the largest part of a wheel, setting the scale at any inch mark, and then measuring the smallest part, the amount of wear is easily ascertained. The depth of a flat spot can also be accurately measured by calipering the surrounding surface, setting the scale, and then with it measuring the depth of the depression. For boring tires where standard gages are not available, this form of caliper can be used. The wheel center is first measured, and

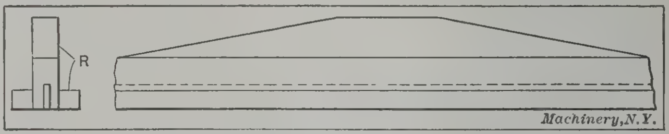

Fig. 2. Method of Stiffening Steel Beam of Larger Calipers with Wood

the inch mark on the scale is then set to exactly coincide with the edge *I*, after which the scale is fastened. As the pieces *D* are each, in this case, 4 inches long, the head *B* is moved exactly 8 inches, plus the amount to be allowed for shrinkage; the outer ends of points *D* will then be set correctly for boring the tire. When turning a wheel center to fit a tire, this operation is reversed; that is, the tire is calipered and the head *B* moved outward the required amount.

The beam of the caliper shown in Fig. 1 is steel and the tool takes in 31 inches. Calipers of larger size have stiffening ribs *R* of wood as shown in Fig. 2. By referring to Fig. 1 it will be seen that the end of the beam extends beyond the head *C*. This is to protect the measuring point, as the end of the bar would strike first if the tool were dropped endwise. This caliper will be found very handy in a locomotive shop.

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AUTOMOBILE FACTORY PRACTICE*

THE DAYTON MOTOR CAR CO., DAYTON, OHIO

ETHAN VIALL†

The recent hard times, as many in the machine tool line have known them, have as a rule, been regarded as a huge joke by the big automobile builders, for a large majority of them have run full or double time and then could not fill all their orders promptly. So far behind have many of them been that they had to get some of the parts made elsewhere, and the Dayton Motor Car Co., Dayton, Ohio, maker of the Stoddard-Dayton automobiles, has been no exception in this respect. In fact, the company has found it necessary to extend its plant by the erection of an immense steel and concrete structure, now nearing completion, that will nearly double its already tremendous capacity.

This firm actually makes, as the word is understood in the manufacturing world, about 95 per cent of its car, which is a high percentage when one considers the average automobile shop, or even some of those of national reputation, which in many cases are little more than assembling plants. The firms in the same class with the Dayton Motor Car Co., when it comes either to size, methods, quality, or output can be numbered on the fingers, with several to spare. The forging department alone is as large as some good-sized factories. Here everything in the nature of a forging which is used on the automobiles, with the exception of the crank-shaft, is made; even the big elliptical side springs are made up complete in this department from the plain steel strips to the finished article which is tested out in actual service.

This firm is also one of the few which has its own foundry, thus insuring a more nearly uniform product than can be obtained from a jobber. Then, too, the body tops are cut, sewed and finished and cushions are made in their respective departments. Wood is bent into shape for the bodies and top braces and, of course, all painting and finishing is done in the plant. There is, besides the complete line of manufacturing departments, a big garage and repair shop maintained especially for the quick repairing of disabled machines of their own make that may be shipped or brought in.

Crowded as are the conditions in the factory just at present, the shop practice itself stands out clear and strong, the equal of anything in the country. This does not mean that every machine is original or built especially for the work to be done, for at the present stage of the automobile business this is no longer necessary, but where special machines or tools have been needed they have been built, and built in a way that speaks well for their efficiency and length of usefulness.

The most vital part of an automobile is the motor and it is around this part of the machine that the interest of a mechanic usually centers. Many of the parts cannot, for lack of space, be followed through the various routes they take in the shop, but the practice of different factories varies to such an extent regarding piston rings, pistons and cylinders, that these parts will be taken up pretty much in detail, and a few other more or less important or interesting points will also be touched upon.

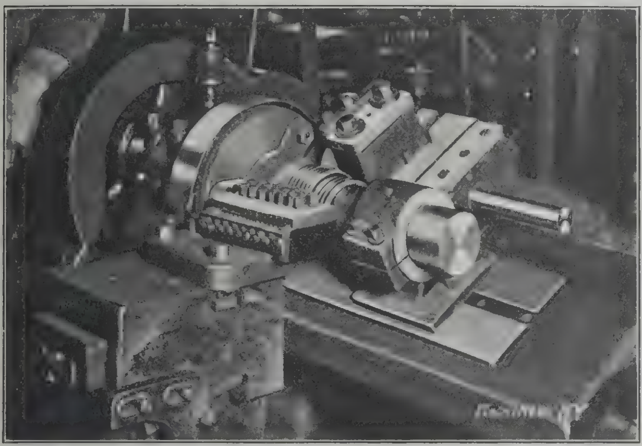

Fig. 1. Turning, Boring and Cutting-off Piston Rings in a Gridley Machine

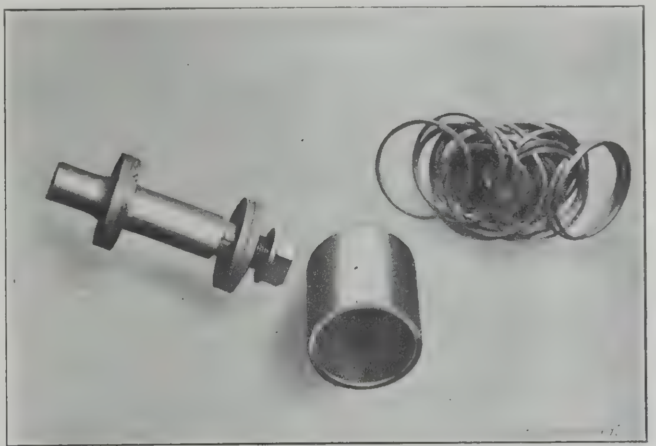

Fig. 2. Mandrel for Holding Rings when Grinding the Outside

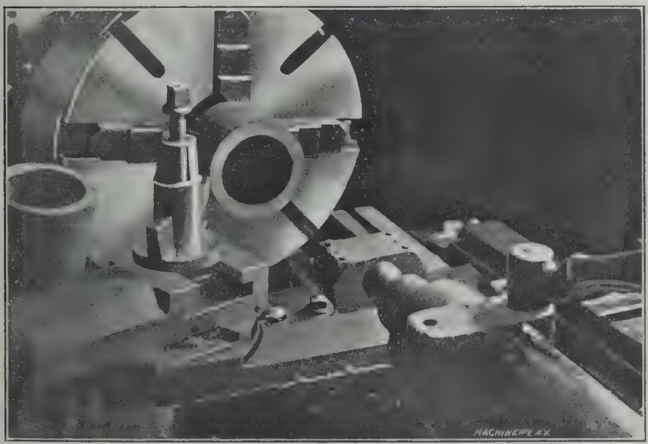

Fig. 3. Facing the End, breaking the Inside Edge and boring out the Piston

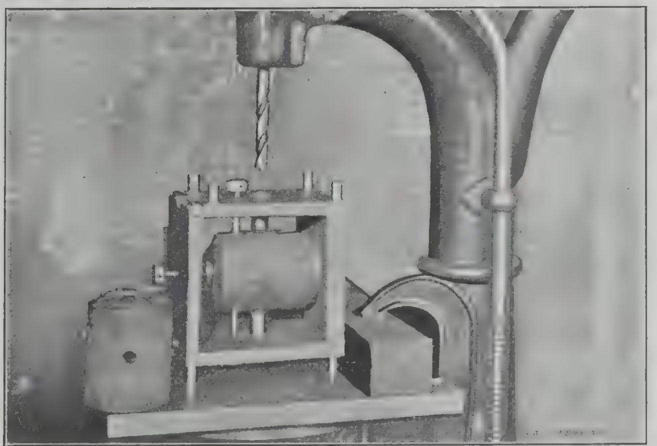

Fig. 4. Jig for Drilling the Wrist-pin Hole in the Piston

Making Piston Rings

Piston rings go through comparatively few separate operations, as three of the operations are done simultaneously on one machine. The piston-ring casting is made with three large flanges or lugs on one end for the purpose of bolting it to the face-plate. The holes in these lugs are laid out by hand and drilled in a drill press and the casting is then bolted to the face-plate of a Gridley semi-automatic piston ring machine which is shown in Fig. 1. This machine bores out, turns eccentric and cuts off the rings, all the operations going on at once. The motion of the turning-tool carriage which turns the outside of the casting eccentric while the inside is bored concentric, is obtained by a cam on the back of the face-plate. After leaving this machine, the rings are taken to the grinding department which is in charge of Mr. C. A. Smith, and placed one at a time on the magnetic chuck of a Heald grinder, and the sides are ground. They are next split with a milling saw and are then ready for the finishing of the outside, which is done by filling the cast-iron sleeve,

* For additional information on this subject, see "Machines and Tools for Automobile Manufacture," June, 1909, and articles there referred to.

† Associate Editor of MACHINERY.

shown in Fig. 2, with the split rings, placing it over the mandrel, putting on the loose flange and screwing on the nut. The sleeve is then removed, the mandrel placed on centers and the outside of the rings ground. The rings are now ready for the final inspection from which they are passed to the assembling department.

All of the operations on piston rings which have been just described, as well as the following ones on pistons, except the grinding operations, are done in what is known as the screw and turret department, in charge of W. F. Hittle.

The Piston Processes

The first machining operation done on a piston, is to place it in a four-jawed lathe chuck as in Fig. 3, with the open end outward, and true it up by the cored hole. The outer end is then faced off, the inside edge broken or beveled slightly with the same tool and the inside bored out to the wrist-pin bosses by the boring head shown in the tail spindle. The casting is next placed in the drilling jig, Fig. 4, and the wrist-pin hole is drilled. The work is located in the jig by means of a plug which fits the hole just made by the boring tool. Next, the piston is placed in a Gridley automatic and

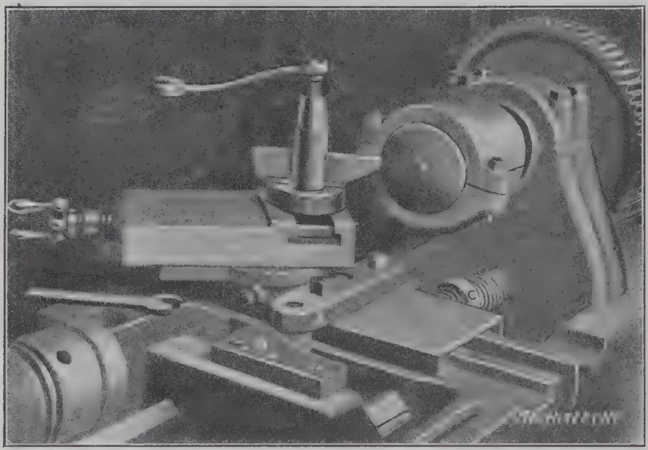

Fig. 5. Lathe equipped with Forming Slide for Turning Spherical End of Piston

the outside, the piston ring grooves, and body clearance are turned. The piston is held in the machine by means of a stub mandrel, on the nose of the spindle, to which it is fastened by a long eye-bolt running through the spindle and tightened by a hand-wheel at the back. A short piece of heavy iron rod is also inserted through the wrist-pin hole in the piston and the loop of the eye-bolt. The piston is steadied on the cut by a follow rest.

From the automatic, the piston is taken and placed in the hollow chuck shown in Fig. 5, and the closed end rounded. The cross-slide of this lathe is especially fitted with a bracket *A* carrying a roller which is pressed against the former *B* by the heavy spring *C*. On being taken from this lathe, the piston is placed in another and held in the same way as on the automatic, while the end is centered and the ring grooves

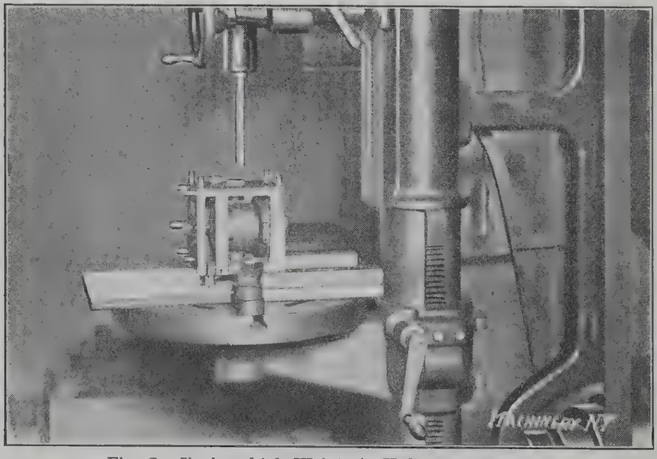

Fig. 6. Jig in which Wrist-pin Holes are Reamed

are carefully trued and sized. The piston is then placed in a Brown & Sharpe grinder, between a large and a small center and the outside ground to size; then it is inserted in the jig shown in Fig. 6 and the wrist-pin hole is reamed out. The final machining operation is to place the piston in the special machine Fig. 7, for the purpose of milling out the space between the wrist-pin bosses for the end of the connecting-rod. In this machine the work is held and located

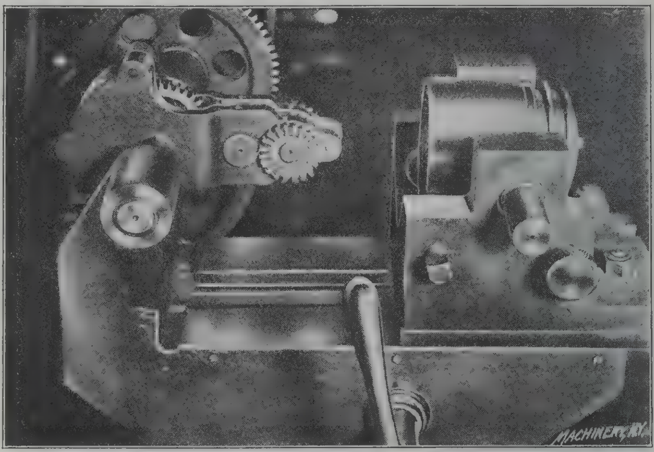

Fig. 7. Special Machine for Milling the Space between the Wrist-pin Bosses

between V-jaws with plugs inserted in each end of the reamed wrist-pin hole. The mechanism operating the mills is too plainly indicated to need further explanation. Just before the last inspection, the pistons are placed in the jig shown at *B*, Fig. 8, and the wrist-pin hole is carefully hand-reamed with a pilot reamer.

Machining Cylinders

Cylinders of the several types used on the different models of Stoddard-Dayton motors, are all machined in the machine shop which is in charge of Mr. Walter Sigler. These cylinders are of two general types: One having the water jacket cast in one piece around the cylinder with no openings other than the pipe openings, while the other type has a large opening fitted with a removable cover, both types being cast in units of two cylinders each; so made that they may be easily

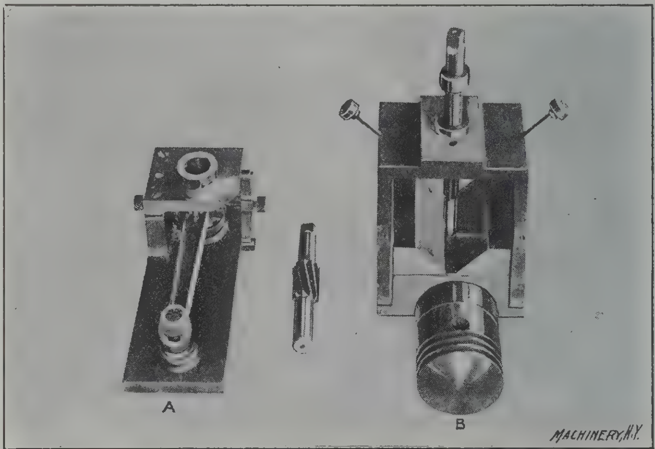

Fig. 8. Reaming Jigs for the Crank End of the Connecting-rod, and the Wrist-pin Hole in the Piston

grouped in multiples. The first machining operation on the first-mentioned type, consists in boring out the cylinders on a regular Beaman & Smith cylinder boring machine Fig. 9. This machine is arranged to hold four two-cylinder units at a time; two of the units being in position for boring while the other two are being set into the fixture. After one set has been bored, the fixture is reversed and in this way no time is lost in setting up the work. The second operation consists of drilling and reaming the valve holes in a turret-head drill press Fig. 10, the cylinder unit being held in a jig as shown. In the third operation, the water-pipe holes are drilled and tapped, and then the cylinders are strapped onto an angle-plate and the spots for the exhaust pipe flanges are surfaced off in a vertical mill. They now pass through several minor drilling operations before they are ground and given their final inspection.

The second mentioned type of cylinders, having the water-jacket covers on the sides, are bored out on the Beaman & Smith machine in the same way as the first type. The cover seats are then surfaced off in a mill and the cover holes

drilled and tapped using the jig shown in Fig. 11. The work is next placed in the indexing or tilting jig, Fig. 12, and the valve holes drilled, bored and reamed. In all, ten holes are finished in this jig. Instead of using an angle-plate to hold these cylinders while surfacing the exhaust pipe flange spots, as in the first instance, they are placed in a special fixture shown in Fig. 14.

leather padded covers being clamped over the two large ones, then filling the jacket with water, attaching a pressure gage, connecting to an air hose and running the pressure slowly up to seventy pounds, all the time watching for any indication of a leak from a crack or a flaw. A similar preliminary test is also made in the machine shop on all cylinder water-jackets before machining and after boring out the cylinders.

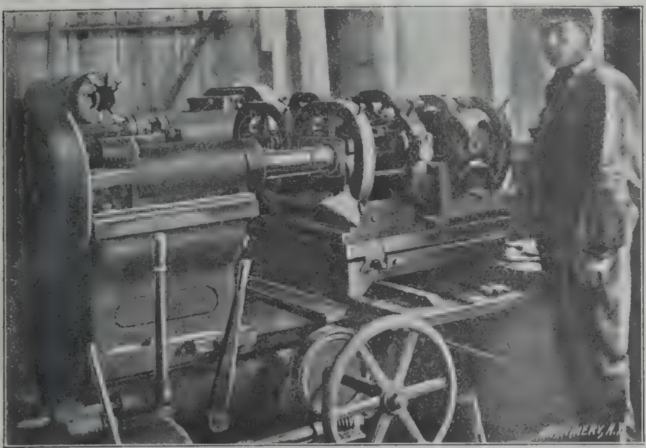

Fig. 9. Boring out Cylinders on a Beaman & Smith Machine

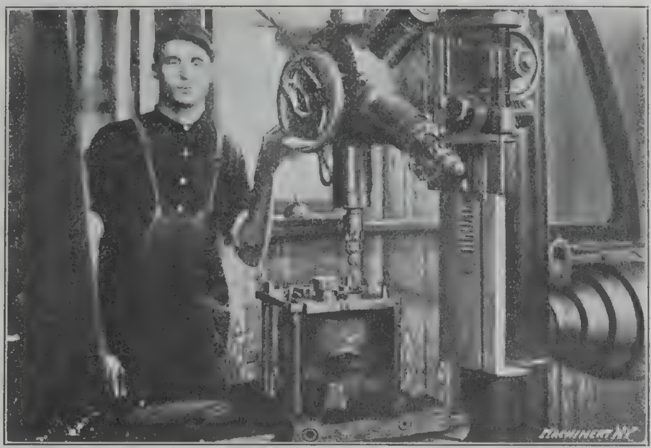

Fig. 10. Drilling, Reaming and Seating Valve Holes

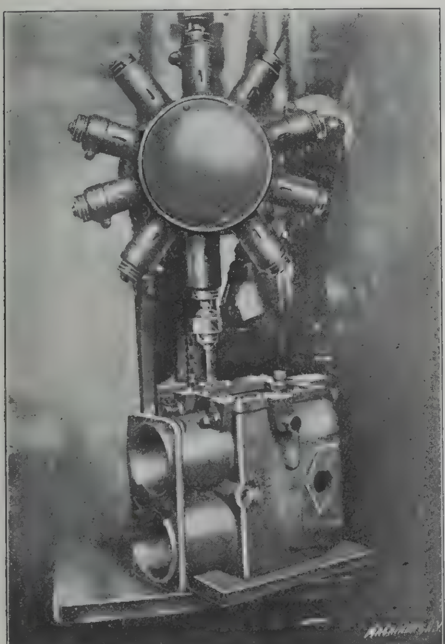

Fig. 11. Drilling and Tapping Holes for Water Jacket Cover

Fig. 12. Tilting Jig for Holding Cylinder while Drilling and Reaming Valve Holes

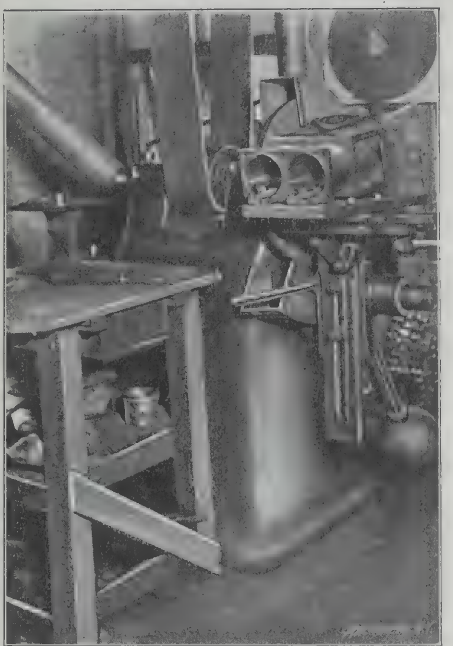

Fig. 13. Finishing Seats for Water Jacket Cover on a Besly Disk Grinder

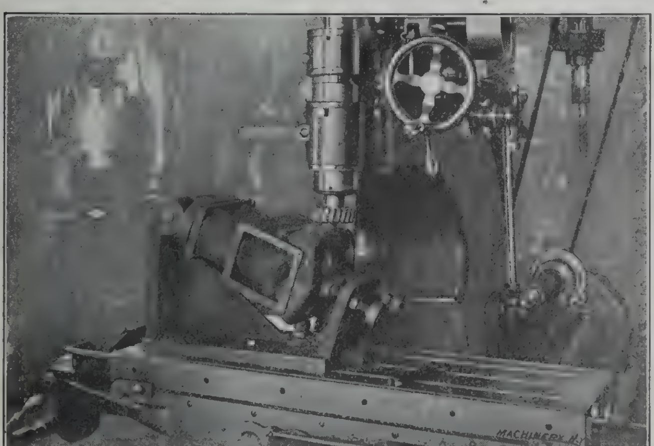

Fig. 14. Fixture for Holding Cylinder while facing Exhaust Pipe Flange Bosses

Fig. 15. Testing the Water Jackets

After all the machining operations are finished, these cylinders are sent to the grinding room and the water-jacket cover-seats finished smooth and true on a Besly disk-grinder, as shown in Fig. 13. The cylinder bores are ground on a Heald grinder.

Before being assembled in the motor, the cylinder water-jackets are tested under seventy pounds water pressure, as shown in Fig. 15. This is done by stopping up all openings,

After the connecting-rods are drilled and reamed in a box jig, the final reaming is done in the motor part assembling department, the jig shown at *A*, Fig. 8, being used for this purpose.

Cover-seats on the differential cases, are surfaced off on a Becker-Brainard vertical milling machine as shown in Fig. 16, only the cross and table feeds being used to mill the almost circular rim of the cover seat.

Push-rod fork-ends are milled with a gang mill, eight at a time, on a Le Blond milling machine as in Fig. 17, the clamps of the jig being arranged so that the tightening of one nut clamps two rods as shown.

Milling Drive-gear Clutch Teeth

In Fig. 19 is shown the way the three clutch-teeth are milled in the gear-clutch end of the drive-gear sleeve, using a three-spaced indexing jig. Fig. 20 shows the same sleeve reversed for milling the teeth in the drive-shaft end, while Fig. 21 shows the way the clearance is milled on the teeth. A wedge is inserted under the bottom of the fixture so as to give it the proper angle, and a wider mill is used. It will be noted that clearance is shown on the teeth in all three engravings. This is because a finished sleeve was used while taking the pictures, no partly finished ones being available, but of course in actual work the clearance is milled in the order given.

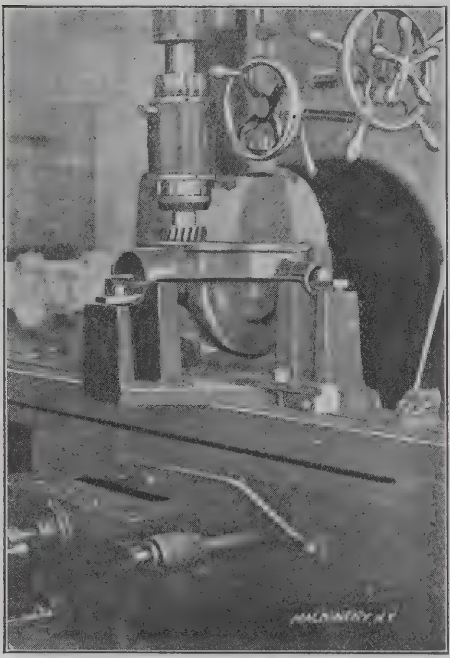
Fig. 16. Facing Seats of Differential Covers in a Vertical Milling Machine

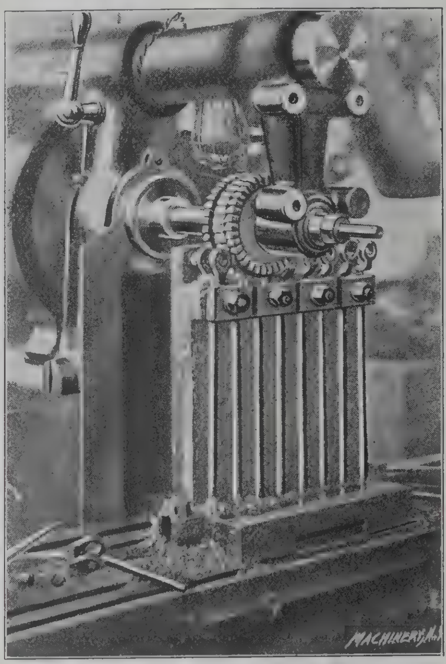
Fig. 17. Milling Eight Push-rod Fork Ends at One Time

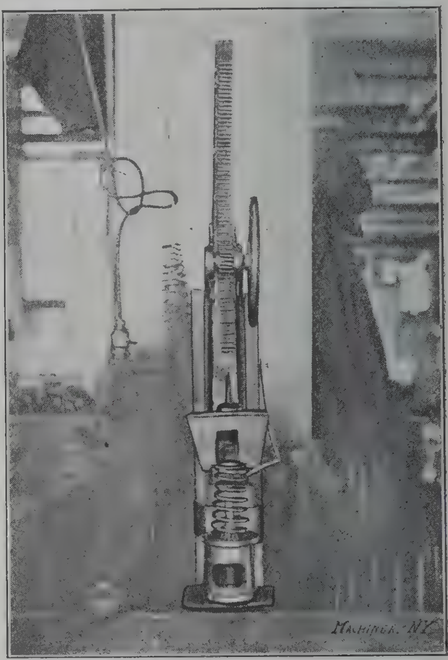
Fig. 18. Device for Compressing Valve Springs when Assembling Cages

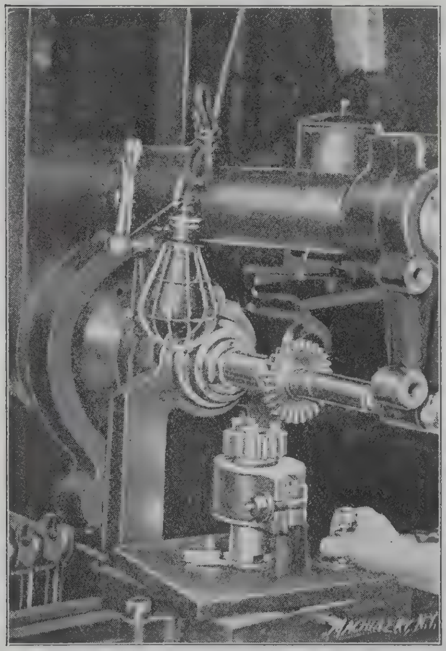
Fig. 19. Milling Clutch Teeth in Gear-clutch End of a Drive-gear Sleeve

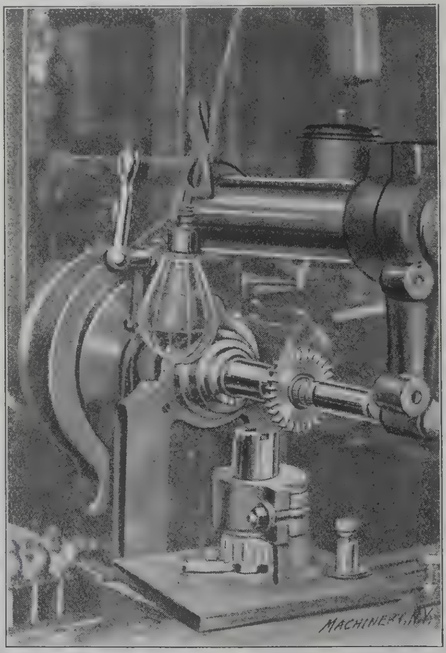
Fig. 20. Milling Clutch Teeth in the Drive-shaft End of the Sleeve

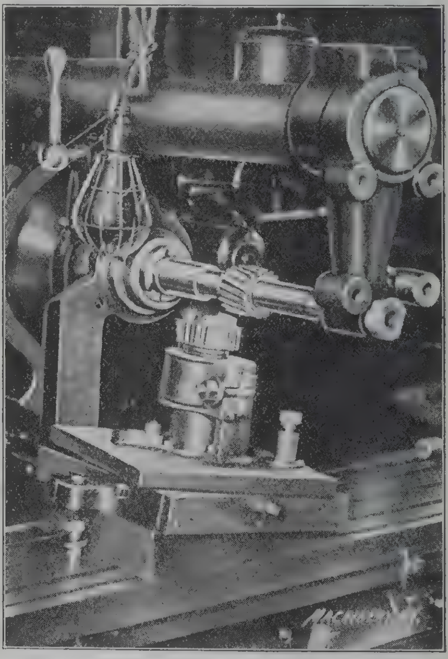
Fig. 21. Milling the Clearance on the Clutch Teeth of a Drive-gear Sleeve

Small valve cams are milled on a Garvin milling machine fitted with a Brown & Sharpe cam attachment (Fig. 22); they are then ground on a special grinder. On the new models, however, the cams and shaft are forged in one solid piece and are to be ground on a new, special grinder, now almost completed.

Crank-shaft bearings are bored out and then hand reamed in the reaming jig shown in Fig. 23; they are then broached out on a La Pointe broaching machine, the broach and guides shown lying on top of the crank-case in Fig. 24 being used. This unusual way of finishing the bearings, saves hand scraping and does a better job in far less time.

In the motor parts assembly department, in charge of Mr. L. C. Miller, there are a number of interesting things devised to expedite assembling; one of them, shown in Fig. 18, is an old paint-press made over to compress the valve springs so that the retaining washer and cotter-pin can be easily placed on the end of the valve stem, when assembling the valve-cage parts. The engraving shows a lower valve-cage and parts in position in the press ready for the compression of the spring and the placing of the washer and cotter-pin.

Crankshafts are held as shown in Fig. 25, while fitting the connecting-rods, which is much better than the usual method of holding them in a vise.

The adjustable motor assembling stands Fig. 26, are as convenient as any I have seen in use anywhere. As the engraving shows, the bed of the motor is bolted to the stand top which may be placed in a horizontal, 45-degree or vertical position on either side, as desired.

The forging department or steel shop as it is called, in charge of Mr. F. E. Sellars, is one of the most complete of any similar department of an automobile factory in the country. It is fitted with big steam hammers, board drops, forging machines, punch presses, bulldozers, special benders and

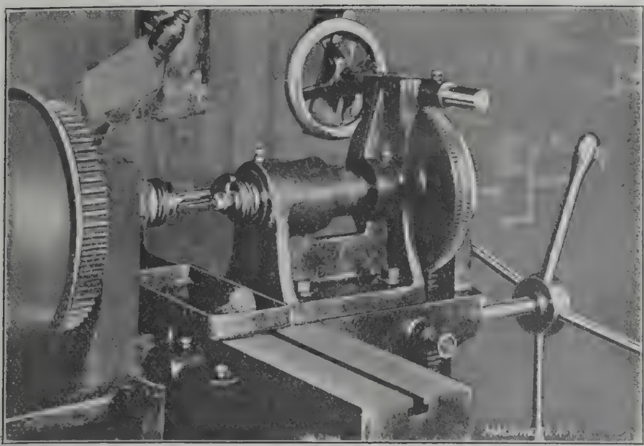
Fig. 22. Milling Small Cams on a Machine equipped with Brown & Sharpe Cam Attachment

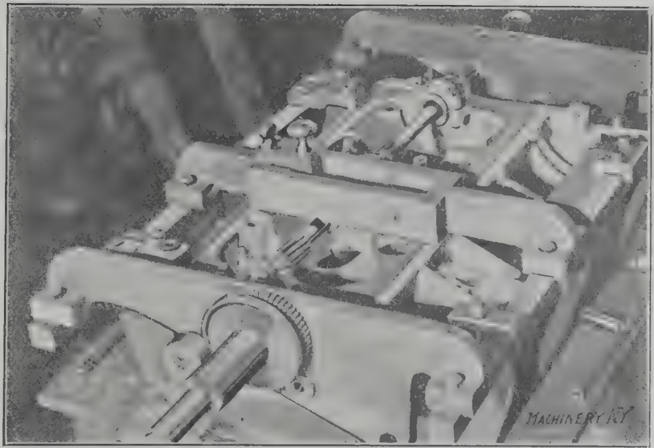
Fig. 23. Reaming Jig for Hand Reaming Crank-shaft Bearings after the Boring Operation

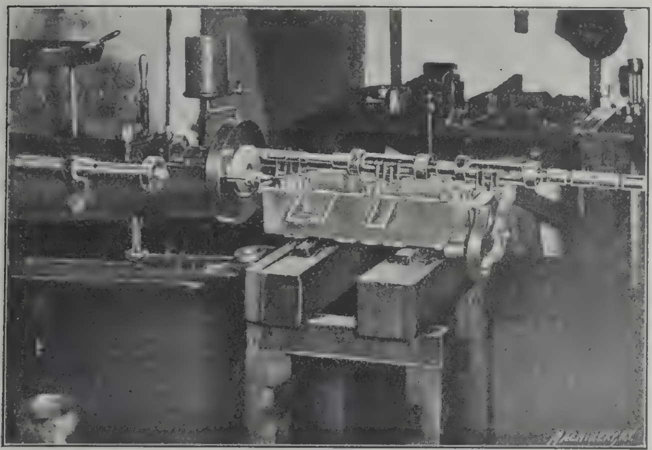
Fig. 24. Special Broach for Broaching Crank-shaft Bearings after they are Reamed

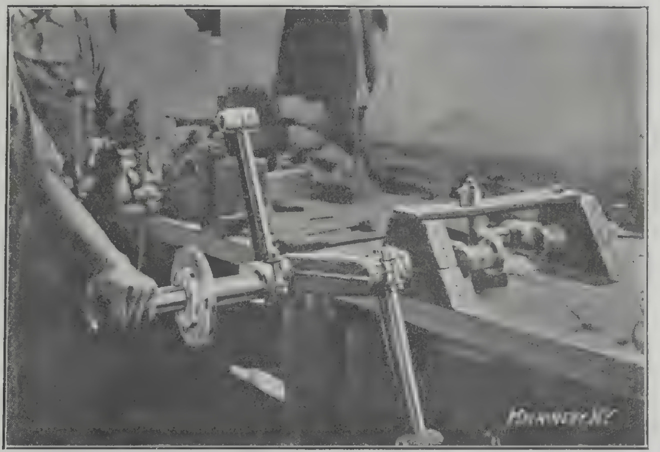
Fig. 25. Bench Clamps for Holding Cranks while Fitting the Connecting-rods


Fig. 26. Adjustable Stands for Motor Assembling


Fig. 27. Barium-chloride Hardening Furnaces and Cooling Tanks

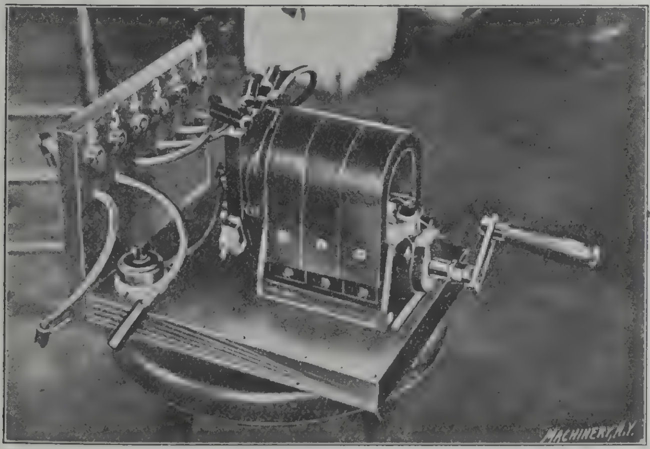
Fig. 28. Apparatus for Testing Magnetos

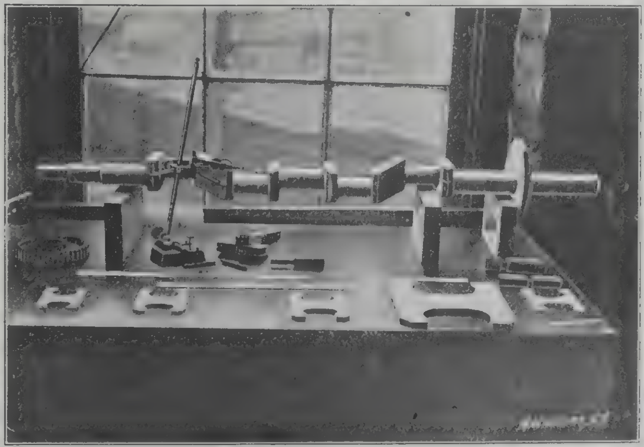
Fig. 29. Various Gages used for Testing Crank-shafts

heating furnaces, and everything that is used that is a forging, as was previously stated, except crankshafts, is made here. Even the long, channeled frame-slides are formed out of the heavy steel bands in which form they come from the steel mills, and the holes in them are punched, using a big templet as a guide instead of laying out the holes and drilling as fre-

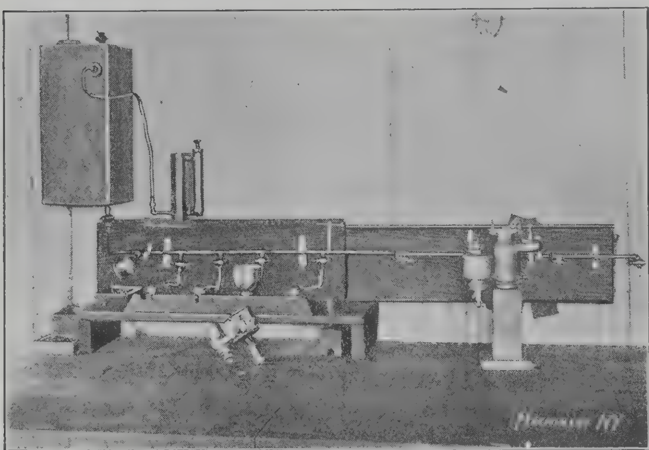

Fig. 30. Apparatus for Testing Carbureters

quently is the case. This department also contains the most complete barium-chloride tool-hardening plant in the West, with the possible exception of that of the Firth-Sterling Steel Co., in Chicago. A partial view of this department, showing the oil heated crucible furnaces used for melting the barium chloride, is shown in Fig. 27.

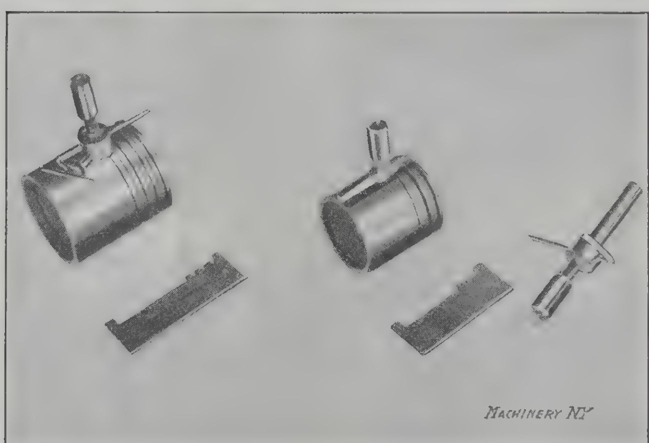

Fig. 32. Piston Gages

The motor testing department, in charge of Mr. George Gorton, is also very complete, being fitted with all the necessary testing apparatus and a French manograph. As in all factories doing high class work, the testing and inspecting departments are the ones on which the reputation of the product depends, for no matter how good the design is, if

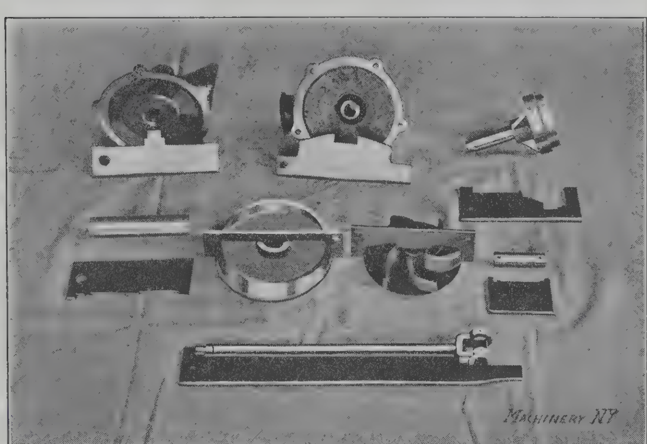

Fig. 34. Some of the Parts which are tested by the Templet Gages

the testing or inspecting is not thorough, the good designing soon is lost sight of by dissatisfied users. Recognizing this, the most rigid inspection is given all parts between each operation and before they are used or sent out. Of all the inspecting departments, that of the motor parts inspection in charge of Mr. M. Manny will probably be of the most interest to readers of MACHINERY. In this department, purchased parts are given an especially careful test as to material, workmanship and efficiency. Magnetos and their timers are carefully tested as shown in Fig. 28. This apparatus consists principally of a board with spark-plugs numbered to corre-

Fig. 31. Spring Testing Device

spond to the number of cylinders to be operated. These plugs are joined to the timer by suitable connections and a crank is fastened to the spindle of the magneto, so that by turning this crank and watching the resulting sparks, the tester can easily see if the spark-plugs respond in the correct order and with a spark of the proper "fatness."

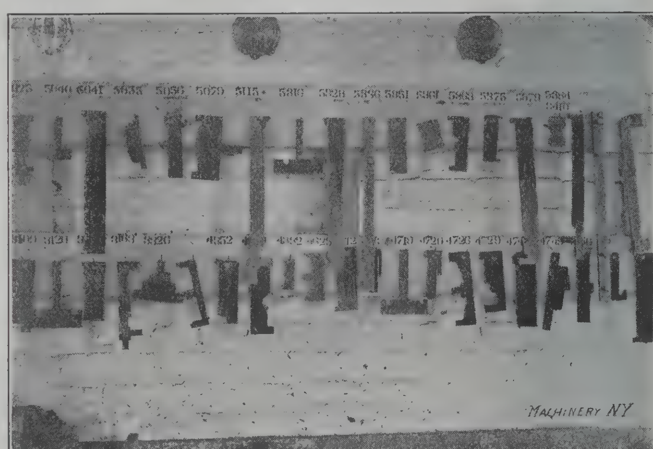

Fig. 33. Group of Miscellaneous Templet Gages

Crankshafts are tested on the large surface-plate shown in Fig. 29, the parallels, limit gages, indicators, scales and parts shown being used.

Carbureters are tested for leakage as shown in Fig. 30, a gasoline tank and pump to give the proper pressure together with a pressure gage and suitable fittings making up the

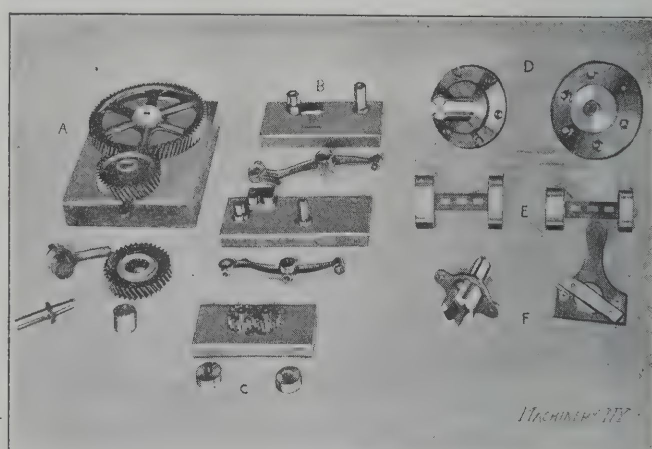

Fig. 35. A Number of Gages used in Testing Motor Parts

apparatus. Schebler carbureters are tested at ¾ pound pressure, and Stromberg's at 2 pounds.

Valve and push-rod springs, are tested as shown in Fig. 31. These springs are tested according to certain tabulated data. For instance, the spring shown must give a pressure of 60

pounds when compressed to 2⅛ inches, a slight variation being, of course, allowable.

Pistons are measured for diameter, and the angularity and size of the wrist-pin hole, the length of the piston, the depth, spacing and size of the grooves are tested with the gages and templets shown in Fig. 32.

A group of flat metal templets, used for various purposes is shown in Fig. 33, and the way some of them are used for testing pump and other parts is shown in Fig. 34.

At *A*, Fig. 35, is a device for testing the center distance and proper meshing of the timing gears, the small gear being mounted on an eccentric pin with a small lever attached, and the center distance being obtained by calipering the centers when the gears are properly meshed. At *B* are two rocker-arm contact gages; *C* is for testing small pump gears, the disks being used to test the accuracy of the pins from time to time; at *D* are two flywheel bore and drilled hole gages; at *E* are two Brown & Sharpe limit plug-gages and at *F* is a valve plunger guide and gage.

Fig. 36. Cylinder Bore Limit Gages

Fig. 36 shows a cylinder and three bore gages. The middle one is standard, the one at the left is 0.002 inch small, and the one at the right is 0.002 inch large, while in case of doubt the inside micrometer is used.

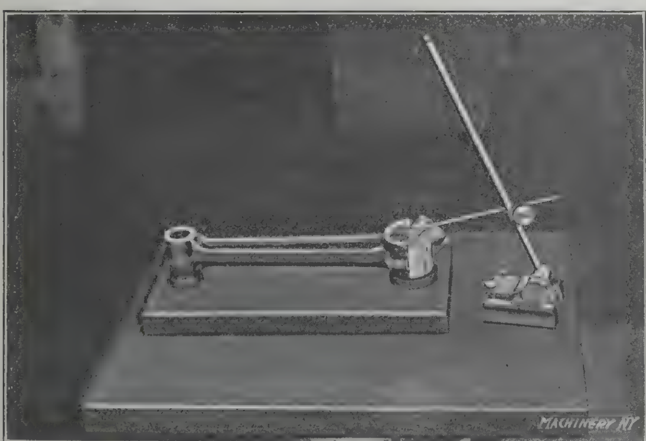

Fig. 37. Method of Testing Connecting-rods

Connecting-rods are tested as in Fig. 37, the pins in the plate being exactly the proper distance apart and of the correct diameter. The surface gage is used to test the amount of offset at the large or crank end.

In preparing this brief description of a few of the interesting things to be found at the Dayton Motor Car Co.'s plant I am especially indebted to Mr. Harry Tuttle, Chief Engineer Edwards, Supt. Houk, and also to Mr. A. C. Miller, the well-known racing man, who acted as guide.

* * *

According to the *London Financial Times* a new patent law was enacted in Austria last December which came into force in June this year. This law contains a section similar to that of the new British patents act by which patents in Austria will be revocable at the expiration three years from the date of publication, without any notice, if the patent is not worked in Austria to an adequate extent.

FACE-PLATE FOR ECCENTRIC PISTON RINGS

CONTRIBUTOR

The design of a special plate to be secured to an ordinary face-plate for holding any work to be either bored or turned eccentric, is shown in Fig. 1. When turning eccentric piston rings, for example, any degree of eccentricity can be obtained from zero to the maximum amount that the plate is designed to give, and, in addition, all the operations such as boring, turning and cutting off the rings can be performed at one setting of the casting.

The construction of the plate is clearly shown in Fig. 1. The outer part *C*, to which the work is attached, is secured to a plate *D* by the bolts *E* and *F*. The bolt *F* acts as a fulcrum for the plate *C*, which swings upon it to either of the extreme positions of eccentricity indicated by the dotted lines *B*. The hole in the part *D*, for the bolt *E*, is elongated as shown in the elevation so that the bolt is free to move when the plate is being set over for eccentric turning or boring. The spring *H* serves to keep the faces of the two plates in contact when the nuts are slacked off to permit the plate *C* to be moved. This prevents the possibility of any dirt getting between the plates. Assuming that it is first necessary to turn a piece of work, the casting would be set true by the outside, with the locating plate *C* in its central position *A*, in which it runs true with the face-plate proper. After the turning operation, the two nuts on bolts *E* and *F* would be slacked off slightly, and the locating plate pushed over the required amount. The nuts would then be tightened and the inside bored to the size required; the outside, of course, would be running eccentric. By graduating the plate as shown at *G*, it can be quickly set to any desired amount of eccentricity.

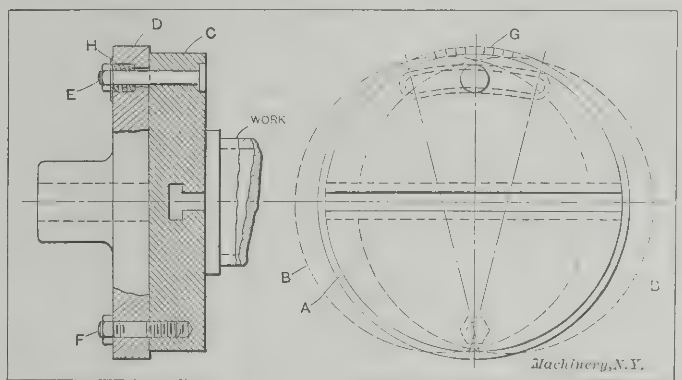

Fig. 1. Special Lathe Face-plate for Turning Eccentric Rings, etc.

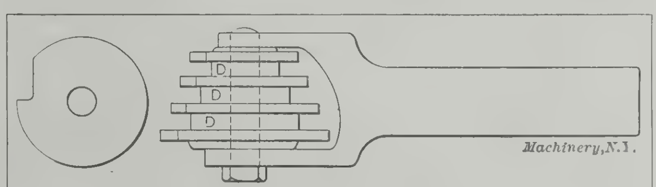

Fig. 2. Cutting-off Tool for Piston Rings

The tool-holder shown in Fig. 2, which is equipped with circular cutters, may be used to part the rings to the correct width. As will be seen in the illustration, the distance pieces *D* determine the width of the rings. These distance pieces should be made of mild steel as it affords a better surface grip than if hardened steel were used. The shape of the cutters is shown by the outline to the left of the engraving.

* * *

The number of automobiles in use in Germany slightly exceeds 20,000. The number in use in the United States has been estimated to be 160,000, or twice the number of the automobiles in use in the whole of Europe. There are 69,000 automobiles registered in New York state alone. In a statement recently published by the American Motor Car Manufacturing Association, the number of concerns building automobiles in the United States is given as 253, and the capital invested in the automobile industry, including that of kindred trades, sales-rooms, garages, etc., is nearly $200,000,000.

SUGGESTIONS FOR A MODEL BLACKSMITH SHOP*

JAMES CRAN†

Buildings for manufacturing purposes are as a rule constructed more or less in accordance with recognized standards that have been adopted on account of their adaptability for the particular class of work they are to be used for. In plants of the larger machine-building concerns and similar industries usually all buildings are of the same general style throughout with the exception of the blacksmith or forge shop, which is often entirely different. Why this should be, no good reason is apparent from a practical point of view, as the style adopted is often less suitable for the purpose than that of the other buildings, and the result is that very often blacksmiths and forge men have of necessity to work under conditions that are anything but an incentive to the best results. Workmen, no matter what the nature of their occupation may be, will do more and better work under pleasant and attractive conditions than they can be expected to do in a gloomy atmosphere. In this respect blacksmiths are no exception to the rule. As their art is indispensable to all other industries, a few practical suggestions that would have a tendency, if adopted, to reduce cost, increase and improve production for the employer, and bring about better conditions for the blacksmith, may not be out of place.

The principal essentials of a blacksmith shop where maximum production at minimum cost is expected are light, ventilation, sanitary arrangements and sufficient space to accommodate a full equipment of machinery and appliances systematically arranged and installed. What the writer considers a basis that could be worked from in constructing, equipping and arranging blacksmith shops from a few forges capacity to the largest is shown and described in the following:

Foundations and Walls

To begin with, the foundation has first to be considered. Where a rock bottom can be had very little preparation for building is necessary, but where building has to be done upon sand, clay or swampy ground it is important that the foundation be made thoroughly solid, otherwise the jar from steam hammers and other machinery will have a tendency to warp and crack the walls. The construction, in general, like buildings used for other purposes, should be governed to a certain extent by the class, size and weight of the work that has to be done. If used for light forging exclusively, the walls need neither be as high nor as heavy as where the work is varied or of large proportions. For light and medium weight work walls need not be more than from 15 to 20 feet in height, but for heavy work or where it is of a wide variety as in railroad or heavy machine building shops the walls should be from 20 to 25 feet in height so that there would be sufficient space between the tops of large steam hammers and the roof trusses for the free use of jib cranes or other overhead lifting and conveying devices.

Very little can be said regarding the foundation specifically, as general conditions and the nature of the site would have to be taken into account before any authentic information could be given, other than that it should be made as solid as possible. The walls, preferably of brick or reinforced concrete, should be of a more substantial nature than is generally required for other purposes. The piers between windows may be supported either with pilasters or buttresses or a combination of both. For the admission of plenty of fresh air which is essential in all manufacturing buildings, especially in blacksmith shops where more or less heat is radiated from forges and furnaces, the windows should not be over 36 inches above the level of the floor. If placed higher in the walls, which is often done to save their being broken by flying pieces of iron or steel, or to conform with a pet theory of protecting the men employed from drafts, they are too high to be of much benefit other than admitting light, as the greater portion of the air admitted enters at a point too high to benefit the workman or to keep the lower portion of the shop where heat is generated cool enough to be comfortable. Plain sash windows that can be raised from the bottom and lowered from the top are the best type to use and can be protected inside and out with wire screen. In locating doors it is well to have one in each end of the building large enough for the admittance or removal of any kind of work or material and to have others in the side walls where they may be required.

Forge Space and Arrangement

The next thing that calls for attention is the amount of space that is necessary for each forge. This depends very much upon their arrangement. If they are grouped as is customary in some shops, a saving of space is effected, but work in general cannot be so conveniently or economically handled as when they are arranged in rows, for the reason that in groups men from some of the forges will either have to pass between other men and their forges or anvils or take a long roundabout way to and from steam hammers; not only this, but work is often of a shape that can only be handled to advantage on forges with at least three sides accessible. It is therefore advisable that they be arranged in rows sufficient distance from the walls to allow of portable vise benches, surface plates, etc., being used where the light is best and moved from place to place as they are required without necessarily taking them into the center of the floor or between blacksmiths and steam hammers. With forges installed from 5 to 6 feet from the walls and 16 feet of space allowed for each as shown in Fig. 1 there would just be sufficient space around them for the tools generally used at the anvil and the convenient handling of all ordinary blacksmith work. For light work they may be placed a little closer than 16 feet, but more difficulty is experienced in trying to do work in limited space than where there is sufficient room. Wherever conditions will permit it is preferable to have blacksmith shops, if they exceed the capacity of 10 forges, wide enough for a row on each side with corresponding rows of steam and power hammers facing the forges on the side of the shop in which they are installed.

Forges used for the average range of blacksmithing are from 36 to 48 inches in width. With these placed 5 feet from the walls and anvils from 18 to 24 inches out from the line of forges the distance from wall to anvil will be approximately 11 feet. At least 12 feet of clear space should be allowed between the line of anvils and steam or belt-driven hammers, the bases of which are anywhere from 5½ to 8 feet in length. As a certain amount of space behind the hammers is necessary, 10 feet more may be added. Thus a shop of approximately 40 feet in width is required for single rows of forges and hammers and 80 feet for double rows. The advantages of a short wide shop over a long narrow one are obvious. It is more compact and better under the observation of the man in charge. The space back of the steam hammers is doubled, making the center of the shop wide enough for a line of car tracks which may be standard or narrow gage, and the handling of work too long or of a shape that could not be advantageously handled by ordinary means. Not only this, but the saving in actual construction, which would amount to about one-third, is an item too important to be overlooked.

There are, however, certain elements to be contended with in the construction of a wide building that can be entirely dispensed with in a narrow one. When a building exceeds a certain width some supports for the roof other than the walls are necessary if cost, which is a prime factor, is to be kept at the lowest margin. These roof supports are generally in the form of columns so arranged that the weight is evenly divided. In blacksmith shops columns or supports should be located where they would offer the least obstruction to the handling of work which is almost invariably hot, and the success of the various operations of shaping it depends upon reaching a steam hammer in the least possible time after it is removed from the fire. It is therefore obvious that the fewer obstructions there are to be avoided the greater the probability of the work being successfully accomplished. Just behind the line of steam hammers, columns would be entirely out of the way and would serve the double purpose of supporting the roof and traveling cranes or trolleys.

* For data previously published on this subject, see MACHINERY, February, 1904, "Machine Shop Equipment—Equipment of the Forge Shop."

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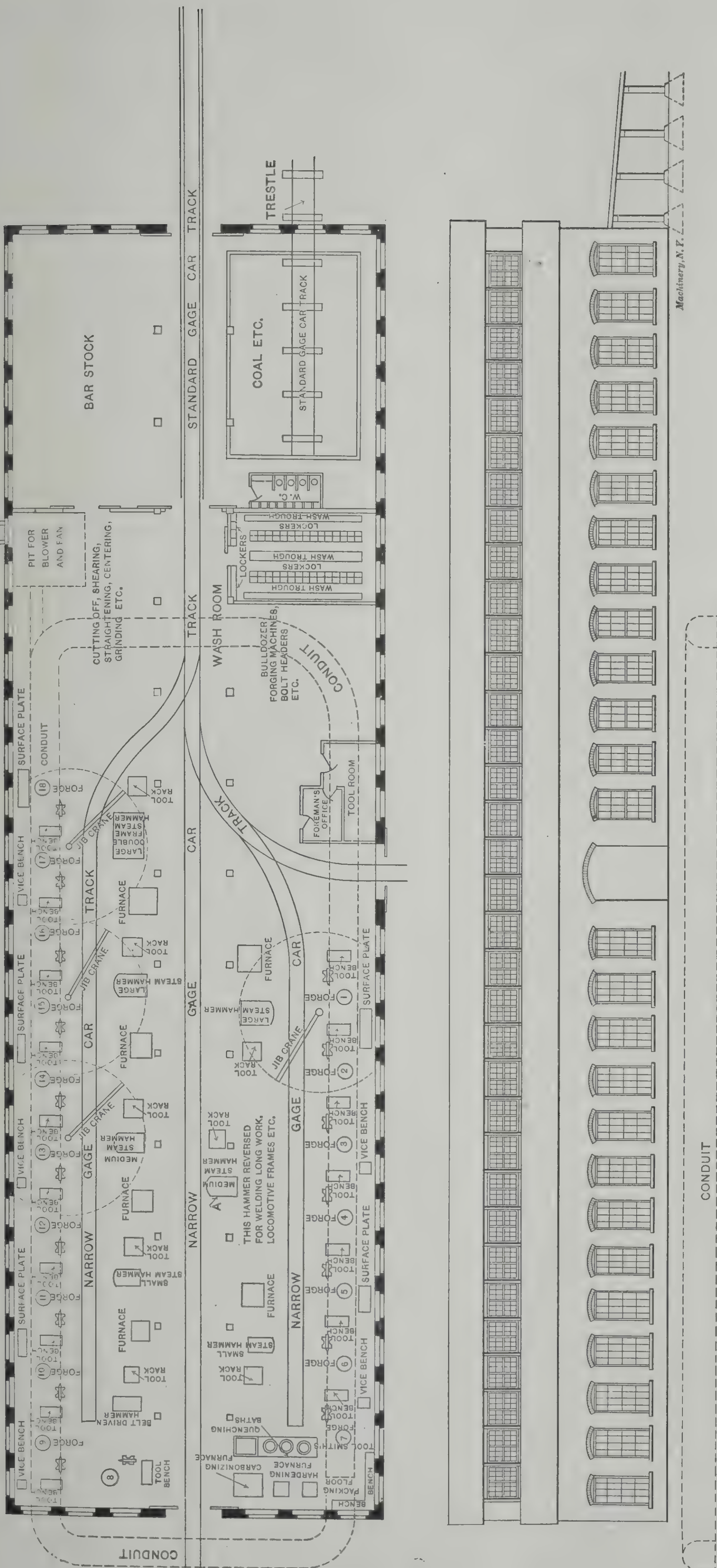

Fig. 1. General Layout and Side Elevation of Blacksmith Shop

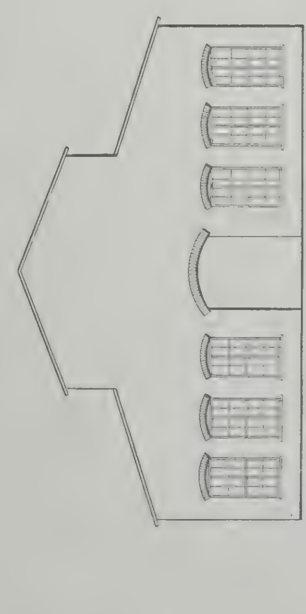

Fig. 2. End View of Blacksmith Shop

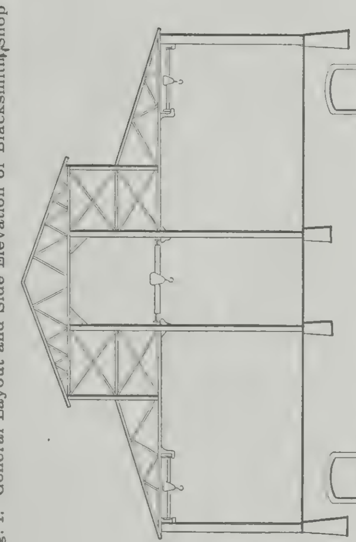

Fig. 3. Cross-section, showing Travelers

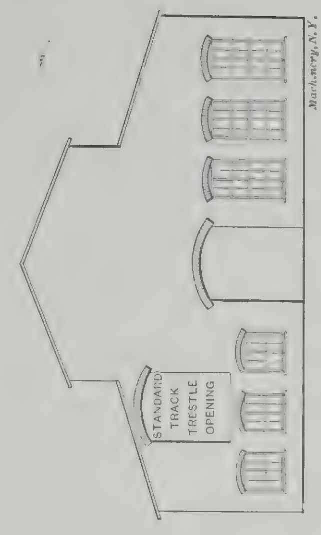

Fig. 4. End View, showing Car Trestle Opening for Discharging Fuel

These points considered and provision made for the storing of bar stock, coal and other materials used in blacksmithing in the same building or adjacent to it constitute the most important features of an ideal blacksmith shop, which may be constructed, laid out and arranged as follows, or the general idea used as a basis to work from.

The general arrangements of a shop of 18 forges in which provision has been made for a full equipment of appliances generally used in a shop of that capacity are shown in Fig. 1. One end is assigned to material, as bar stock, coal, etc., and space for cutting off and centering machines, in short all that is required for putting work in proper condition to be turned over to the machine shop without workmen having of necessity to go outside the building. Forges are arranged in rows 5 feet from the side walls, with those intended for the largest and heaviest work nearest to the stock supply for which one end of the building is exclusively assigned. All forges are served by an overhead trolley system, one cross section of which is assigned to each forge for lifting and supporting work at the anvil. Forges for the larger work are further supplied with jib cranes so arranged that the column is well out of the way of work so that one can be used for conveying to and supporting at the steam hammer the work of two forges, the furnace being located near the hammer that it serves.

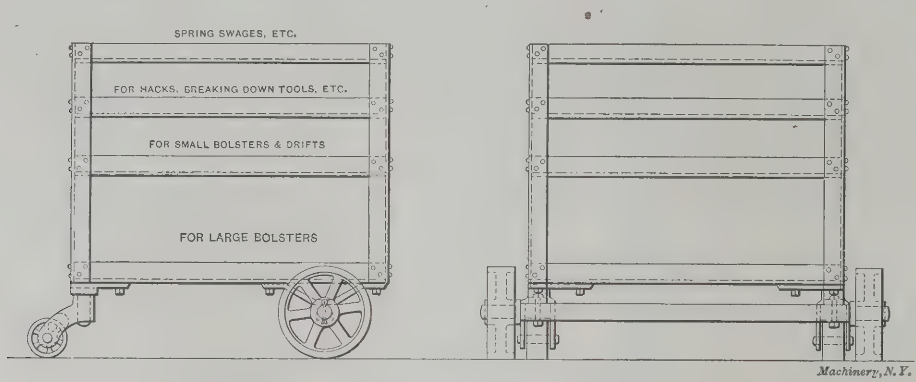

Fig. 5. Portable Rack for Steam Hammer Tools

Fig. 6. Upright Rack for Light Bars

Arrangement of Steam and Belt-driven Hammers

All power hammers, steam and belt-driven, with the exception of one, which will be referred to later, are installed in rows facing the forges at a distance of 12 feet from the line of anvils, which is just sufficient space for the general range of blacksmith work being done at steam hammers without conflicting with that being done at forges. The steam hammer *A* which is reversed and out of alignment with other hammers can be used for such work as welding long shafts, leadscrews for long lathes, locomotive frames or any other work too long or of a shape that could not be advantageously handled by ordinary means. This class of work is supported by hooks from an overhead trolley and heated in a portable forge so arranged that it drops clear of the work when it is ready to be conveyed to the hammer by turning a lever. This forge was shown and described in MACHINERY, December, 1908, in connection with an article on welding. No definite information can be given upon the number of steam or power hammers necessary for any given number of forges, as that would depend very much upon the class of work to be done. Sometimes three or more blacksmiths could use the same hammer to block out their work without wasting time in waiting for turns or one man's work conflicting with another's, while on other kinds of work one man may monopolize one hammer for a time. In any case the equipment of hammers and other power appliances should be ample for the requirements, otherwise much time may be wasted in men having to wait after their stock is heated before they can have access to a hammer or in having to leave it before an operation is completed. In a shop of 18 forges where work is of a wide variety of shape and size, from 6 to 9 hammers will be required. Generally a great part of machine blacksmithing, especially blocking out, can be much more economically heated in furnaces than is possible when forges are used exclusively. It is therefore advisable to use furnaces for all work that can be heated in them and have them as near to steam hammers as is practicable. In most of the blacksmith shops connected with manufacturing plants one or more toolsmiths are employed and more or less carbonizing, heat treating, annealing, hardening and tempering has to be done. This class of work should be as much concentrated as possible, located in the shop where it would be least likely to conflict with other work and be under the charge of a subforeman. Saws, shears, cutting-off, straightening and centering machines, together with any other machine tool that may be used, should be located near the stock supply and if possible near the point from which finished work is forwarded to the various departments where it is wanted. These machines and all bar stock would constitute a department that could be attended to by a sub-foreman.

Location of Blowers—Conduits—Piping

The blower for supplying forges and furnaces with blast and the fan for mechanical draft, if a down-draft system of carrying off smoke and gases is to be used, may be installed as near to each other as is practicable and operated by the same mechanism, preferably motor drive. Common practice is to elevate blowers and fans above the level of forges; sometimes they are placed upon a platform in the roof trusses to save floor space. This practice is not to be commended for the reason that when the wind gate of a forge or furnace happens to be left open when the blower is closed gas generated by the still ignited fuel upon the forge enters the pipes and naturally rises. It may escape through the blower unless it happens to be started up before the fire upon the forge has died out. When this happens the gas is forced back upon the still burning fuel where it is ignited, causing an explosion which may ruin pipes and damage the blower. If blowers and fans are installed in a pit below the level of the floor they are more accessible and the danger of being damaged by explosions is minimized from the fact that gas will not descend except when forced. Generally blast is conducted from the blower to forges and furnaces through a main pipe which is reduced in size as it passes the various branch pipes which connect with the forges. This has a tendency to make the pressure greatest near the terminal

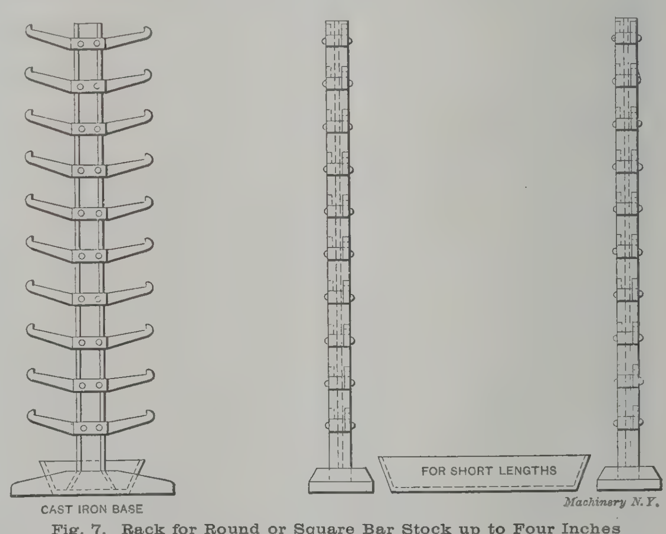

Fig. 7. Rack for Round or Square Bar Stock up to Four Inches

of the main pipe. To equalize the blast pressure at all points the main pipe should be in the shape of a loop, both sides of which may be of equal capacity to the discharge of the blower so that it would act as a reservoir permitting of branch pipes being connected with it at right angles instead of the more acute angles generally used, and should it be necessary to increase the blowing facilities or enlarge the capacity of the shop this could be done without changing the blast pipe. In an ideal blacksmith shop all piping should be where it is least likely to be in the way and still be accessible. For this purpose an underground conduit in the shape of a loop directly under the line of forges as shown by dotted lines in Fig. 1 and in cross-section in Fig. 3 of a size sufficient to accommodate the entire piping system including blast, steam, water, gas, oil, compressed air, heat for warming

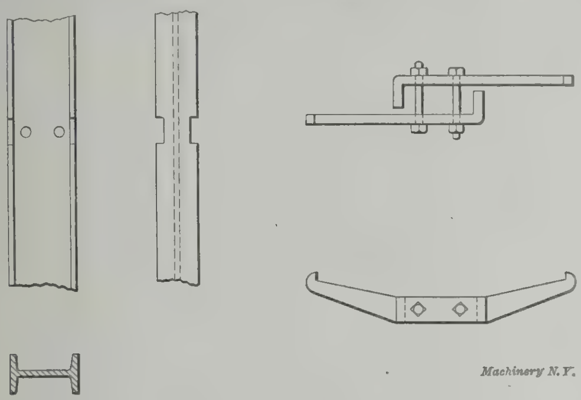

Fig. 8. Detail of Upright and Arms for Rack shown in Fig. 7

the shop in cold weather, smoke, sewer or any other piping or wiring that may be necessary and to which access may be had through openings in the floor between forges. These openings should be lined with concrete covered with slatted platforms upon which blacksmiths could stand at their work and through which heat could be admitted in cold weather and cool air in warm weather either through the heating system or openings in the walls fitted with gratings and shutters that could be opened and closed at will. The water supply which is essential in all blacksmith shops is more important than is generally supposed; each forge ought to be provided with a slake tub, the water in which should be kept fresh. If this has to be carried from a general supply pipe as is customary in most shops, much time is wasted both in emptying and refilling the tubs that could be turned to good account if a faucet and sewer connection is located near each forge and elsewhere about the shop where they may be required.

steam and power hammer there should be a tool rack, preferably portable, of which Fig. 5 is an example, that would accommodate a full set of spring swages, fullers, breaking down tools, hacks, bolsters or any other appliances that may be used in connection with hammers, each tool as far as possible being assigned to its own place upon the rack. This would overcome the disadvantage of having to turn over a miscellaneous heap of tools usually stacked upon the floor to find the one that is wanted and to move them individually should the space they occupy be temporarily wanted for some other purpose.

To get the greatest efficiency from steam power hammers the foundations upon which they are mounted must be solid. Concrete resting upon hard pan has given better results than the combination of heavy wooden beams and concrete commonly used. In installing solid concrete foundations there should be several inches of cement placed over the concrete and a cushion of wood at least three inches in thickness placed between the cement and the base of the anvil to give the necessary resiliency and prevent the concrete being pulverized by the impact of the blows. Back and front of the hammers there should be openings down to the level of the anvil base so that it could be leveled or adjusted by wedging up and grouting with cement if for any reason it should get sagged or out of alignment with the upper parts of the hammer. These openings should be covered with hatches level with the floor.

By conducting steam to hammers from the main steam pipes in the underground conduit through branch pipes provided with traps the disadvantages and annoyance caused by condensation are practically obviated, providing the supply pipes are enclosed in non-conductive casing until they are connected with cylinders. The exhaust and all other pipes leading from hammers may be accommodated in the same casing down to the floor level, where they may be conducted outside the building through conduits and allowed to discharge in the usual manner or be turned into a condenser and ultimately into the sewer.

Foreman's Office, Wash Room, Lockers, Etc.

The foreman's office and the room used for special tools, fixtures, formers, welding compounds, etc., should be connected, if possible, and located centrally in a position from which the whole or the greater part of the shop could be easily seen and if possible near the door that is used the most. If that happened to be a side door, office and tool-room may be as shown in Fig. 1. Should an end door be more convenient the office and tool-room may occupy the space assigned to forge No. 8. For convenience as well as

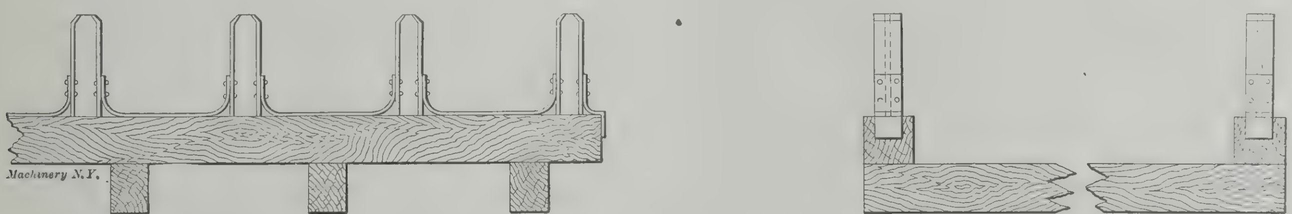

Fig. 9. Rack for Heavy Bars

These connections should not be made directly with the tubs, except at forges used by tool-smiths or where hardening has to be done, as it is often necessary to move tubs and other appliances at forges used for regular forging to make room for work of unusual shape.

Furnaces—Tool Racks—Hammer Foundations and Piping

Furnaces to be used for heating work that is to be blocked to shape in quantities at steam hammers and those used for heating material to be drop-forged or shaped in forging machines, bolt-headers or bulldozers may be heated either with solid fuel or oil. Oil is preferable for several reasons. It is conducted from the supply tank to where it is to be used automatically through pipes. Once ignited the supply can be regulated and the heat maintained at an even temperature for any length of time. There is practically no refuse to be removed and no time is wasted in waiting for a fresh supply of fuel reaching the proper temperature for the work to be done as is the case with any kind of solid fuel. For each

economy blacksmith shops should be provided with washing accommodation, locker rooms and lavatories, which would not only add to the comfort of the men employed, but would be the means of saving the time that is wasted in going to other buildings. In a shop of 18 forges there should be locker and washing accommodations for at least 60 men. This at a conservative estimate would occupy at least 650 square feet of floor space. The lavatory for obvious reasons should be separate from the locker and washroom, but in close proximity, and is therefore shown in the floor plan just beyond the partition that separates the shop from the coal storage.

Flooring

There is much difference of opinion as to the material that is best adapted for the flooring of blacksmith shops. Wood is too inflammable, bricks crack and break from the heat and impact of work being laid upon them, cement or concrete is poorly adapted for the same reason, and asphalt is out of the

question. Nothing that has been tried so far has given better satisfaction or can be installed at less cost than dirt mixed with ashes. If kept moist by being watered at least once every day it is more comfortable to stand upon than anything else that can be used for the purpose. It is easily repaired and leveled should holes or irregularities get worn in it, and it is not affected in the least by hot or heavy pieces of work or material being dropped or laid upon it. The space between walls and forges, however, may be covered with concrete and cement to facilitate the handling of such appliances as portable surface-plates and vises, and the floor of wash-rooms and lavatories may be of asphalt, while the foreman's office and tool-room may be of wood.

The spaces assigned to cutting-off machinery, etc., and that for drop-hammers and other machines used in making die forgings has not been laid out in detail for the reason that machines for that class of work vary so much in general outline and in size that it would be difficult to arrange them satisfactorily except by knowing their makes and the size of work they are to be used for.

Bar Stock Racks and Storage

In storing bar stock several things have to be considered if time is to be saved and the chances of making mistakes in using wrong material minimized. Racks are necessary for the purpose and should be constructed in a manner best suited for the accommodation of the various kinds of material and so that bars can be lifted from the sides instead of having to be pulled from the end, as must be done when the common lattice pattern rack is used. For tool steel or any other special material racks of the type shown in Fig. 6 will be found to be the most convenient, as bars can be stood on end irrespective of length, and short pieces kept in the enclosed portion at the bottom. For the more ordinary grades of stock up to a certain size a rack of the type shown in Figs. 7 and 8 will be found to be very convenient, as bars can be removed from the sides, which is much more expedient than pulling them from the ends. Lengths too short to be supported by the arms can be placed in the box-shaped receptacle at the base. For bars too heavy to be stored upon racks of the types already shown a platform raised a little above the level of the floor and divided into sections by upright stakes, which may either be of cast iron or steel of structural shapes as shown in Fig. 9, may be used. All material to be designated by colors on the ends of the bars to correspond with the colors of the racks in which they are stored.

Communication between the stock-room and cutting-off department should be through sliding doors that would permit of bars too heavy to be lifted by hand, being lifted and conveyed between the two places by an overhead trolley system, to pass through the sliding doors at the point where they come together.

Fuel Storage—Roof Construction

On the opposite side of the building from the bar stock store are the pockets for storing coal, coke, charcoal or any of the other solid fuels that may be used. The approach to these pockets is a line of standard gage car tracks elevated upon trestle work and entering the building through a door in the end wall above the level of the pockets as shown in Fig. 4, this door to be large enough to admit locomotive and cars so that coal, etc., could be dumped directly into the pockets from which it could be supplied to forges or furnaces by hand cars.

The roofing of a building as here depicted apart from general outlines is a subject upon which the constructing engineer ought to be left with a free hand, as stresses must be calculated and tension and compression members of the trusses arranged accordingly. The sides of the ventilating monitor, however, should be at least 6 feet in height to admit of the windows used being of a size sufficient to throw good light upon the anvils at the opposite sides of the shop. These windows should be balanced upon horizontal trunnions so that they could be opened and closed by means of cords or rods operated from the floor.

* * *

The value of the present output of automobiles is estimated to be about $130,000,000 yearly.

HOW OLD SI WAS NEARLY "OSLERIZED"

A. S. ATKINSON*

Native ability is something that is quite scarce in the average machine shop, or at least if it is there it is smothered up or held in check or choked by too much rule-by-measurement practice. Of course I don't mean the ability to run a machine, cut after a pattern, or do any of the other routine work that must make up most of the day's labor in nine cases out of ten. Old Si Smith used to define native ability as "the knack of making something out of nothing." Si had this kind of ability. He was of the old school, hadn't been trained and schooled in an industrial college, and when he served his apprenticeship in the shop there weren't one hundredth as many machines to do your work as there are to-day. A man then had to get out and be his own boring machine, lathe, and planer. There wasn't any monotony about a machinist's job then. Likely as not one day you'd have to weld together a broken rod in the blacksmith's shop or hammer a new point onto a broken bit, and the next you'd be patching up a boiler plate or riveting a steam box to keep it from bursting, or you'd be doing almost anything from filing and scraping down a rough piston to making a new sheet-iron box. There was no standing before a huge machine and watching its rhythmic cutting and pounding, hour after hour.

The old school developed native ability, if one had it in him, and sometimes it knocked a little into one who didn't inherit any from birth. It may be the new method is better for turning out great quantities of exact work, but the day of the man with the knack for doing things has gone for good. Not entirely though—at least one such man is essential to the success of every shop. Just to prove this I will recall some little experiences in which old Si figured. The old superintendent understood Si, and instead of looking upon him as a back number who ought to be "Oslerized," he valued his services for all they were worth. He was always sure of his position in that shop. But the old superintendent died, and another, a stranger to most of us, came to take his place, and with him a new foreman who was about as much a stranger as the head boss. They were both younger than their predecessors, and they believed in hustle and bustle, and method and system. They put everything and everybody to checking off everything and everybody else. They said they wanted to know how much each man was doing, and how much each article cost. I suppose it was all right, as it was modern and progressive. Most of us were young enough to adapt ourselves to the new way and not let it bother us. But it came rather hard on old Si Smith. Si couldn't understand it. He didn't know why he had to be watched and why he had to jot down on a paper everything he did—the time, date, and number of minutes. He protested in vain. "I've been here forty years, an' I never cheated the boss out of an hour of time. I do my work honestly." But this was of no use. "I believe you're honest, Si," the foreman replied not unkindly, "but how do we know whether you're doing your share of the work. It's not so much a question of good intentions as of capacity and efficiency." That stumped Si, and he only stared back stupidly. "What does he mean?" he asked appealingly of us at the noon hour. "Does he mean I don't understand my job or that I ain't up to date, or—or—or—"

Poor Si! We tried to relieve his mind, but it was a dismal failure. Si's particular specialty was fine, careful work. He was not a fast worker, but nothing left his bench until it was perfect. He loved it, and when he did a bit of welding or polishing or cutting with hand tools, it was a pleasure to look at it. He had the machines beat to a standstill. If a machine could cut out a die to a hundredth of an inch, Si could cut another by hand that would come within a thousandth of an inch of perfection. Why, tools in his hands took life and precision that made the work of the rest of us clumsy and bungling. Of course that didn't count in a shop where a new and unsympathetic foreman and superintendent had taken charge. Si couldn't keep up with the pace. His time cards soon showed that. He was slow in his fine work, and at the end of each week the record went against him. You

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see, by their new system, they could tell just how much work each man was doing, and if one was loafing on his job he was told to hustle. It was all intended to increase the speed and weed out the slow ones. The most of the trouble fell upon Si, and within a few months we began to feel sorry for the old fellow. The constant prodding and reprimanding was getting onto his nerves, and that made him slower than ever. This increased his disgrace, and then one day the crisis was reached. Old Si was to be "Oslerized," but owing to his long service in the shop it was only a modified process. He was given a month's vacation on full wages, and at the end of that period he was to return as watchman at a big reduction in wages. We didn't hear the words of the interview. Si was too surprised and dumbfounded to say much; he had to get out and think it over. Then he exploded before us. "They make me watchman on half pay," he said angrily. "Me a watchman, an' too old an' slow to do anything else. I'll go an' drown myself first. No, I'll go to another shop an' get work."

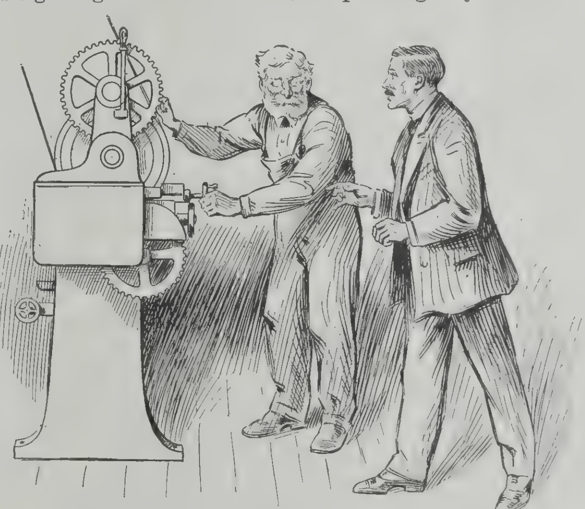
"Does he mean I don't understand my job, or that I ain't up to date?"

This determination we tried to combat, advising Si to think it over and not decide too hastily. He had a month to decide. But he was angry, and he spent a week going from shop to shop for work. But nobody wanted a machinist of Si's age, and they knew nothing about his skill. The following Monday morning Si returned to the shop. He was crestfallen and quiet; he knew now that he had little chance in the new industrial work. "But, Si," we protested, "you have three weeks more of vacation. What are you doing here?" "Vacation?" he stammered. "Oh, yes, I'm having a vacation; I'll spend it here roun' the old shop. There ain't nothing to do but sit aroun' an' look on. I get homesick when I'm away, but I'll have my vacation all right." This, in substance, he repeated to the foreman when he asked Si why he was back. The foreman smiled, and let the old fellow have his way. He was harmless, and so long as he didn't interfere with the work of the others he could hang around and look on. Probably he wanted to get some points from the younger men about increasing his capacity and efficiency.

Now Si's method of looking on was quite different from that of most men. If anything went wrong with a machine he would jump up and look for the trouble. He had an ear tuned so exactly that he could almost anticipate trouble with a machine. The lineshaft couldn't miss a revolution or a gas engine skip once in the most distant part of the building without Si knew it. Once a belt slipped so near the edge of its pulley that it came into contact with a loose guide and bent it out of position. The operator didn't notice it, but Si did. In another minute there would have been trouble, but old Si jumped up and stopped the machine just as the belt slipped off and landed where it would have been caught in another machine. The foreman came up frowning and Si offered only as an explanation: "I saw that belt slipping and stopped it. Them guides ain't no good anyway." The foreman understood the importance of this sudden interference, but said nothing. Si disappeared then into the forge shop. That night after work hours he appeared with a new set of guides which he proceeded to put up. They were so strong and good that they are doing service to-day. Si had forged them out of old metal, and they cost the firm nothing.

On the third day of Si's vacation in the shop a big turret lathe snapped one of its back gears and put it instantly out of commission. We had rush orders on hand, and the crippling of this machine put us in a bad position, as there were no duplicate parts on hand. The foreman was upset, and the superintendent, too. Orders were telegraphed to the manufacturers, but it would mean a loss of several days at least. While the others were bemoaning the fact that the turret lathe would shut down a good deal of the work, old Si was peering into the machine and taking mental notes. When the old thing was abandoned, Si took the fractured parts into the blacksmith's shop, and for several hours was busy. Toward night he returned, black with dirt and grime, and the perspiration running in streaks down his face. He carried something in his hands. Nobody noticed him particularly, but just before the hour for shutting down arrived we were all surprised by hearing the old turret lathe start up and begin rhythmic operations again. The foreman rushed to the place, and there he found old Si beaming happily. "I guess she'll run all right for a few days," he said, pushing his spectacles up on his greasy forehead.

The foreman could hardly believe his senses. He had to stop the machine and get Si to show him what he had done. Oh, it was simple. He had brazed the broken gear until it was almost as strong as a new one—certainly good enough for an emergency. That night a volunteer crew ran the old turret lathe and caught up with the rest of the work. It was nearly a week before the manufacturers' expert appeared on the scene with new back gears, and it took him two days to put them in and finish his job. The foreman after watching the repairs, took a pencil from his pocket and began to do some figuring. We could only guess what it was about. Si didn't know either, but the next day the foreman and superintendent had a conference, the result of which was that old Si was called in the office for a short talk. They had decided that they couldn't afford to lose Si. According to the foreman's figuring he had saved the shop enough by his tinkering



"The foreman could hardly believe his senses"

to pay for his salary several months. There had been danger of losing an important order through the mishap, and Si saved that for them. Si was put back into the machine shop, and he is there now. The Lord knows how old he is; he must be long past the sixty mark, and yet he's as useful as ever. He can't hold his end upon piece work to-day, and nearly every youngster in the shop can beat him. But when they want some very fine piece of work done it is turned over to old Si, and when there's trouble with the machines Si is the expert called in, and its a pretty bad case of breakdown that he can't fix up. He can turn his abilities to almost anything, and when he prescribes medicine the patient generally recovers in a short time.

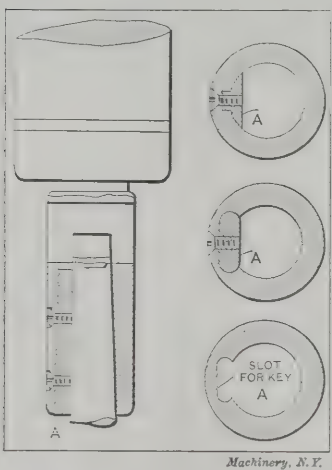
We called him "old saw bones," for he was a surgeon—more than a physician. He could fix up a broken leg or rod or weld together any fracture so that you would hardly see a scar. That is what I call native ability. Si had it, and it certainly was "the knack of making something out of noth-

ing." If he didn't have the right piece of metal to fix a thing he'd make a piece out of old scrap or anything else handy. A shop that doesn't have an "old saw bones" in it is minus one of the most important factors. Give me one of the old school machinists who knows how to handle tools for mending anything, and in the end he will save more than his salary is worth twice over. There are a good many such old men tinkering around, but unfortunately their breed is dying out, and I suppose in time there will be none left. Then we'll have to depend upon the experts from the manufacturers, who will charge a big price and hold up operations for several days or a week every time something goes wrong.

* * *

DRILL SOCKET

Harold E. Bradley has assigned to the Morse Twist Drill Co., New Bedford, Mass., his patented drill socket described in U. S. patent No. 926,845, July 6, 1909. The object of this invention is to provide a drill socket or collet which in addition to its regular function of driving the drill by the tang or flattened end, is also adapted to receive and drive a drill with a broken tang, thus utilizing drills which would otherwise be worthless. The illustration shows a vertical section of the improved socket, and also horizontal sections of alternative designs. The novel feature is the key *A*, which can be readily inserted in grooves in the socket and held in position by screws. After one side of the drill shank is ground or flattened off to correspond with the flat of the key, the drill may be again inserted and driven by the socket.



Drill Socket adapted for driving Regular Taper Shank Twist Drills and Drills with Broken Tangs

* * *

DIES AND PUNCHES FOR MAKING NUTS

One of the latest improvements for automatically making nuts from a bar of metal by dies and punches was patented by George Dunham, Unionville, Conn. (U. S. patent No. 928,509, July 20, 1909). The dies and punches are adapted for an ordinary double crank machine having two horizontally moving punch slides.

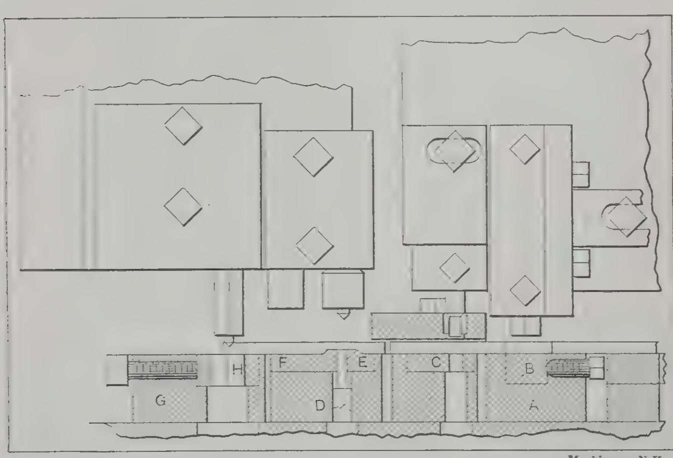


Fig. 1. Sectional View of Dies and Punches for Making Nuts

Fig. 1 is a vertical section of the dies on the bed plate with the punches above. At the right is a die holder *A* with a die *B* having two V-shaped cutting edges, the apices of which face each other. This die cuts V-shaped notches in the opposite edges of the bar and is called the notching die. While each notching punch has four cutting edges, only two of the edges can be used at one time. Adjacent to the notching die is a die *C* with a die block; this die has a round hole for punching the center hole of the nut blanks. The next die holder *D* has a crowning die *E* and a flattening die *F*, the two preferably being made in one piece. The fourth and last die holder *G* has a die *H* for cutting the nut from the bar.

Fig. 2 is a bar illustrating the various steps taken in making the nuts. The notches *d* and the round hole in the nut blank are made by one blow of the right-hand slide. The blank *b* is crowned and the blank *c* flattened by one blow of the left-hand slide. The nut blank *a* is then cut off and trimmed. The next blow of the two slides will form one more pair of notches and perform the previous operations on the blanks *f*, *g*, *h* and *k*. By changing the dies and punches any desired form of nut may be obtained. Square nuts may be made by omitting the notching punches and substituting a trimming die and punch of a square form for the hexagonal one shown.

Fig. 2. Bar, showing Different Stages in the Making of Nuts by Punching

* * *

BORING ELLIPTICAL HOLES

A lathe attachment for boring elliptical holes is described by James Shaw, Dauphin, Manitoba, in U. S. patent No. 928,404, July 20, 1909. The attachment as fitted to a lathe is shown in Fig. 1, and consists essentially of movable supports *A* and *B*, and a boring bar *C* with eccentric end bearings. Fig. 2 is a longitudinal section through the bearing brackets showing boring bar *C*. The ends *D* and *E* are eccentric to *C* and are in alignment longitudinally the one with the other. It will be noticed that *D* and *E* are carried by bearings which can be raised vertically in guideways at the rear face of the supports, while at the other face the main shaft has bearings with horizontal guideways. When the device is in operation the sliding bearings are free to move in their respective ways. In the main shaft is a hole for the cutting tool (see Fig. 2), and in Fig. 1 the tool is shown in position boring an elliptical hole in the work on the lathe carriage.

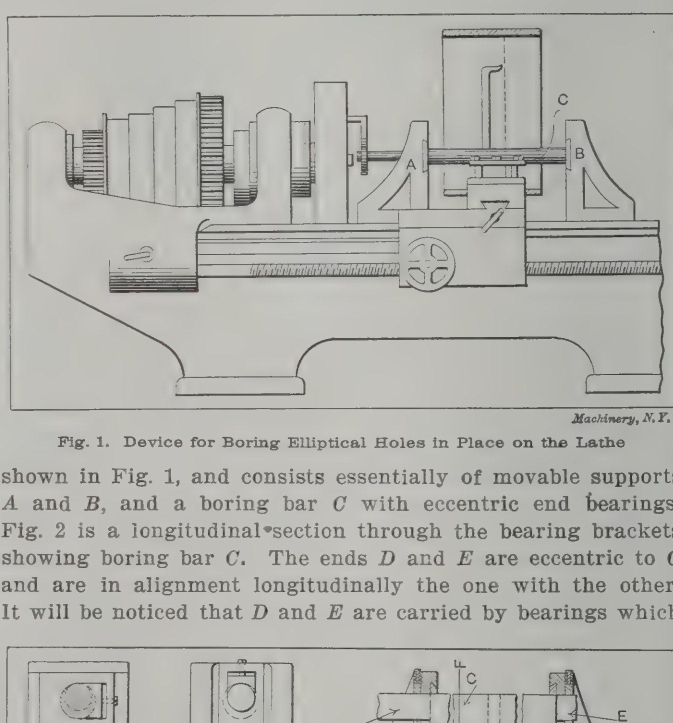


Fig. 1. Device for Boring Elliptical Holes in Place on the Lathe

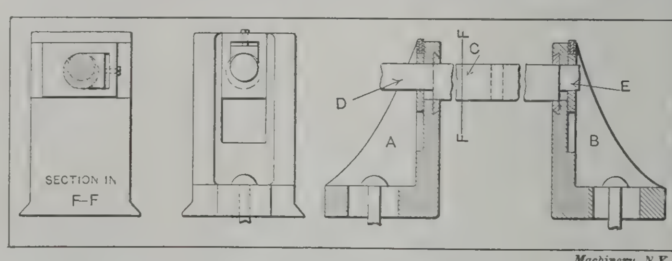


Fig. 2. End and Sectional Views of Elliptical Boring Device

* * *

The chief item of expense in the maintenance of automobiles is generally the tires. Mr. Charles Clifton, president of the Association of Licensed Automobile Manufacturers, says that there are three prime factors responsible for short tire life: First, excessive speed, especially in hot weather; second, rounding curves at a high rate of speed; and third, unnecessary use of mechanical brakes.

MAKING PISTON PACKING RINGS

E. B.

The accompanying engravings illustrate a cheap and rapid method of making expansion rings. This method has been used for some time by a certain gas engine company, and has done much toward reducing the costs of this class of work. Referring to Fig. 1, the dotted lines *A* indicate the shape of the casting from which the rings are made. This consists of a cast-iron cylinder with a flange on one end to facilitate clamping in the chuck for turning and boring. Having chucked the casting in the lathe, the rings are then turned and bored in one operation by means of the tool shown. This tool consists of a frame *D*, which is rigidly connected to the tool carriage and is fed along in the same manner as any other tool. Through this frame passes a spindle *C*, which turns freely in the frame and is held from moving lengthwise by means of a pin *K*, which fits into a recess cut in the spindle. On one end of this spindle there is an eccentric collar *D* which is rigidly held by a pin, thus turning with the spindle. The other end of the spindle is cut square or to some other shape to fit a block with a hole of the same shape, which is fastened to the chuck head. Therefore when the tool is fed along, this spindle slides into the chuck head, and at the same time revolves with it, as does the casting *A*.

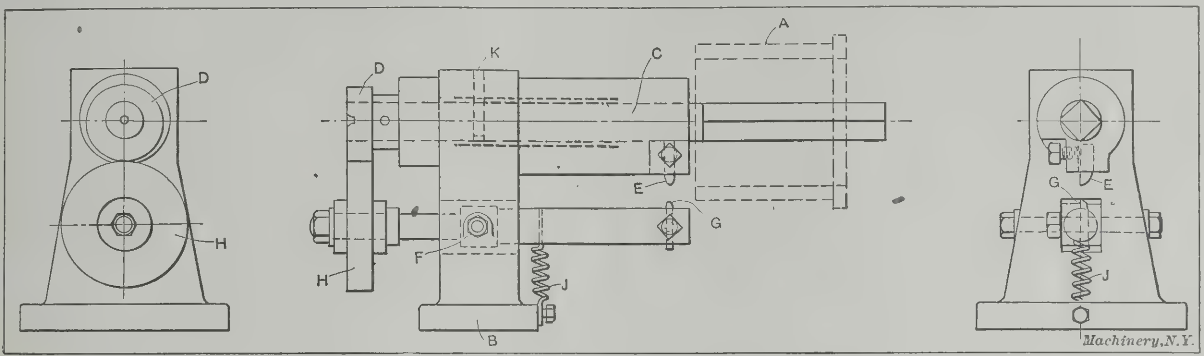


Fig. 1. Tool for Boring and Turning Eccentric Rings simultaneously

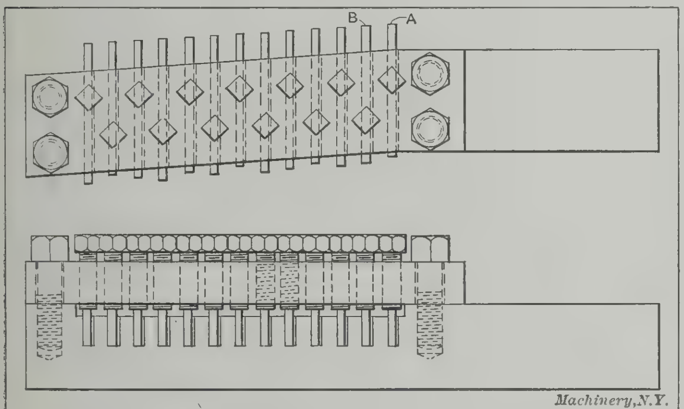


Fig. 2. Cutting-off Tool for Severing the Rings successively

When the casting makes one revolution, the spindle and eccentric also make one revolution. In the frame is set a tool *E* which bores the casting. Through the lower part of the frame passes another spindle or lever which is hinged at *F* and has a tool *G* on one end and a roller *H* on the other end which turns freely on this lever. A spring *J* holds the roller *H* up against the eccentric *D*. As stated before, the eccentric makes one revolution to each revolution of the casting, therefore the lever and tool *G* perform one complete oscillation to every turn of the casting. The tool therefore turns the casting eccentric to an amount depending on the location of the fulcrum *F* and the eccentricity of the cam *D*. This can be better understood if we assume the casting *A*, spindle *C*, and eccentric *D* to be stationary, and the frame *B* to revolve about the spindle. The path of the turning tool would then be in a circle eccentric with the axis of *C*. Therefore, if the frame *B* is stationary and the work *A* revolves, then the outer surface of the cylinder will be cut eccentric to its axis. In this way the casting is turned and bored in one operation.

The next operation is to cut off the rings, and this is done by means of the tool shown in Fig. 2. This tool consists of a bar in which are mounted a number of cut-off tools spaced the proper distance apart to give the desired width of ring. The holder is bent and the tools are set successively at greater distances from the axis of the work. Therefore the tool *A* gets through first and the first ring drops off, and the other rings, throughout the entire length of the casting, are severed in succession.

The next step is to split the rings on the thin side; they are then ready to be ground on the outside. To facilitate this operation a casting, Fig. 3, is bored to such a diameter as will allow for the amount to be ground off. The rings are then sprung into this cylinder as shown by the dotted lines.

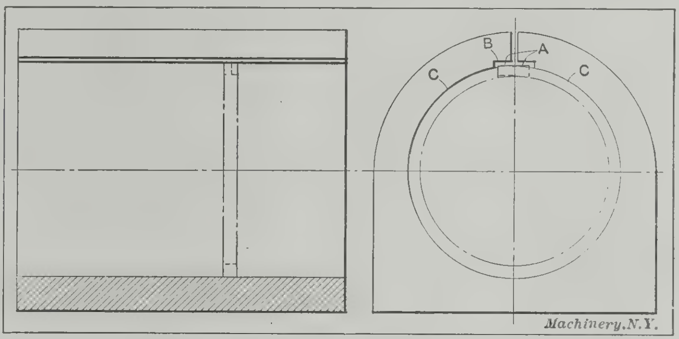


Fig. 3. Fixture for Holding the Rings while they are being secured in the Grinding Arbor

In springing the rings together the points *A* move outside the circle of the bore and the slot *B* is cut in the casting to allow them to do so. This is an important point because if this slot were not provided tne points *A* would be forced in and ground to a true circle with the remainder of the ring, with the result that when the rings were placed on the piston and inserted in the engine cylinder the points *A* would rub on the cylinder walls and a part of the ring, say from *A* to *C*, would be held away and the fit would not be perfect. But if these corners are allowed to project as shown, they will be ground away and will therefore not rub afterward.

Having placed a number of rings in this assembler, an arbor, Fig. 4, is inserted and the rings clamped together between the collars *A* and *B*. The arbor is then placed in the grinding machine and a light cut is taken off the rings. These collars *A* and *B* just fit the cylinder, Fig. 3, and the rings are therefore accurately centered at once. The collars are cut away at *C* to allow the grinding wheel to pass over the rings without cutting away the collars and destroying their usefulness as a centering device.

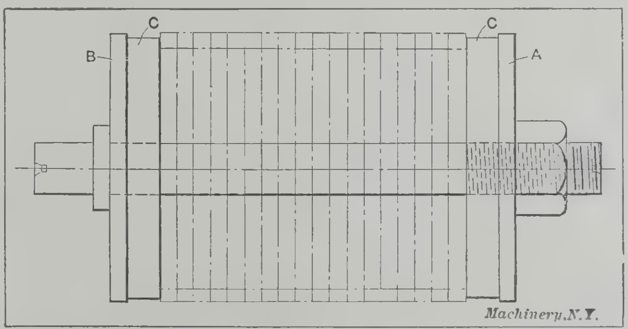


Fig. 4. Arbor which holds the Rings while they are being ground

Rings made in this way have given most excellent satisfaction and fit the engine cylinder perfectly.

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RAILWAY MACHINERY

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We solicit exclusive contributions from practical men on subjects pertaining to railway machine shop practice. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

OCTOBER, 1909

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

HEAT TREATMENT OF ALLOY STEEL

The rapid development of the automobile industry in America has awakened a quick, keen appreciation of the great importance of proper heat treatment of steel. It is pointed out by Mr. Henry Souther that scientific heat treatment is quite as essential as the quality of steel. Ordinary steel may acquire good physical qualities with proper heat treatment, and the best of steel can be ruined by defective methods. There must be thoroughness in the various operations of annealing, hardening and tempering, for treatment carried on with care only makes uniformity of product possible. This is particularly true in the production of drop forgings.

The difference between ordinary steel and the best is great. For example, the elastic limit of ordinary steel is about 40,000 pounds per square inch with a reduction of area of, say, 50 per cent. Nickel steel properly heat treated has an elastic limit of 80,000 to 100,000 pounds per square inch of section, with a reduction of area of 50 per cent, or more. Brittleness does not follow proper heat treatment, the enduring quality being increased in a greater ratio than the elastic limit. Consequently crystallization, fatigue, or whatever we name the cause of breakage, is less likely to develop in a properly heat-treated and tempered material than in an annealed and soft material. This fact, discovered in the laboratory and established in actual practice, is now commonly accepted by metallurgical experts, notwithstanding that it completely overturns previous general belief. Another commonly accepted belief disproved is that strength and stiffness are coordinate, or "the stronger a piece of steel, the stiffer it is." To illustrate, it was thought if one piece of steel were twice as strong as another, it would bend only one-half as much under a given weight. But actual test has shown that a chrome-nickel steel having an elastic limit of 150,000 pounds or more per square inch of section, bends under a given load the same amount as a carbon steel specimen, and this condition holds true as long as the load is within the elastic limit of the weaker material. The elastic limit of a well-tempered steel spring is about 150,000 pounds per square inch, but a spring can be made of soft steel. If it is not loaded beyond its elastic limit, the spring will return to its original shape after every deflection, but the deflection would not be sufficient to make a good spring. In fact, it would be hardly noticeable, and of course, would be of little value.

Between these extremes lie the steels used by the spring makers in the past. Not only has the automobile industry forced the spring makers to depart from their old materials and methods, but the "shake-up" extends all along the line. Assume that a 0.20 carbon steel has been used with advantage for a given design of crank-shaft, neither bending nor breaking through long continued use, and that the bearing surfaces are as small in area as can be used without heating or excessive wear. A crank-shaft of properly treated chrome-nickel steel, having an elastic limit four or five times as high as the 0.20 carbon steel would be no stiffer, but would have greatly increased life and reliability. The steel makers must be prepared to meet these new conditions. Sound knowledge of steel has spread fast among intelligent manufacturers; from the knowledge obtained in the laboratories established where all materials are physically and chemically tested they have learned to discriminate in selection. With known characteristics, heat treatment scientifically conducted is sure of results that make high-grade steels comparable with ordinary steels in about the ratio they, in turn, bear to cast iron.

* * *

THE VALUE OF THE TRADE PRESS

The following quotation from the *Journal of Commerce*, New York, is an unprejudiced statement of the functions of the trade press:

In the very nature of things the man of affairs, with multitudinous and various cares pressing sorely on his time and attention, necessarily becomes self-centered and preoccupied. This is the man for whom the trade press stands as an invaluable ally. While he digs and delves in his own tasks, the trade press is his reliance for more basic information than he imagines. The ordinary press gives him the products of its daily observations in the doings and misdoings of the big round world of politics and society, but what it brings is only a diversion; a stepping aside from his grind. It may refresh him, but it does not aid him in his money-making slavery. But the trade press has an entirely different function in his life. While he toils in his office or warehouse the trade press is performing for him the task of confidential messenger to the rest of the commercial world. Its human machinery is finely tempered and carefully adjusted. Its men are trained, not merely in the collection of interesting facts of ordinary happenings, but in the observation of those events and developments which have a direct bearing on the commercial side of life. The trade press is his organ of communication outward as well as inward. Circulating, as it does, both in a local field and throughout the country, he has but to say the word and his message is disseminated among the very men most interested in his ideas. No man who has ever watched the development of any great trade movement can deny that, without an intelligent, trustworthy trade press, it would have been impossible.

Especially applicable is the description, "an intelligent, trustworthy trade press." The value of the trade journal to the industry it represents is based almost entirely on its trustworthiness. The same carelessness in regard to fact and the tendency to exaggeration which characterize the daily press, would so affect the influence of a trade journal with its readers as to materially reduce its value as a property in a short time. Trustworthiness, accuracy and the qualities which make for reliability, are demanded by the readers of the technical press; and the smallest mistake in a figure or calculation seldom escapes attention.

It is a noteworthy fact that no house organ, or publication issued in the interests of a manufacturer or dealer, has yet developed into a great trade journal. The publications to which the latter term may be applied, we believe, without exception, have started as independent journals, and their development has been strictly along that line. The stronger they grew, the more truly independent they became.

* * *

The growth of the automobile industry is one of the most amazing features of modern manufacturing industry. About 75,000 cars were built in 1909, and, according to the statement of Mr. Alfred Reeves, general manager of the American Motor Car Manufacturers' Association, manufacturers plan to place 200,000 automobiles on the market in 1910.

THE PNEUMATIC TIRE AND THE AEROPLANE

It seems a far cry from the bicycle tire to the aeroplane in the sense that the former is to any degree concerned with the development of the latter, but, according to one who has given the matter some serious thought, it appears that the connection between the pneumatic tire and the flying machine can be logically established. The fact that the automobile is an intermediary in the evolution that has made the latest mechanical triumph possible is interesting now, and it will not be unprofitable to briefly trace the evolutionary process that has made flight actually possible under favorable conditions, and which has aroused high hopes of ultimately making it a practicable means of travel.

The early bicycles of the high-wheel variety were facetiously named "bone-shakers," and bone-shakers they were in truth. The bicycle was only moderately popular in favored places having smooth roads and specially constructed tracks, until the advent of the "safety" and pneumatic tire. The new tire transformed the bicycle from a hard-riding machine, extremely fatiguing to all but those of strong physique, to a vehicle of business and pleasure for young and old of both sexes.

The wonderful improvement in riding quality made in the bicycle by the pneumatic tire stimulated the efforts of inventors and designers to produce a practicable four-wheel carriage driven by power to replace the horse-drawn wagon, and the "tires of air" literally smoothed away some of the great difficulties that had made the horseless wagon impracticable before.

When the running-gear problem was in a fair state of development, attention was concentrated on the motive power, and after a few years of strenuous competition the steam engine gave way to the internal combustion motor which won out because of its simpler control, higher efficiency and greater power per unit of weight. To-day the automobile gas engine is the world's wonder for concentration of power and simplicity of construction. In the space occupied by a Saratoga trunk can be placed a motor capable of generating 40 to 50 H. P. and weighing only from 8 to 10 pounds per horse-power.

Observers of birds and bird flight long ago took note of the strength of their wing muscles and apparent ability to exert great muscular effort in proportion to weight. Whether birds actually exert much power to sustain themselves when once in flight is a mooted question, but it is easily proved that they must expend great effort in the first few moments when rising in the air and getting in motion.

The heavier-than-air flying machine requires a powerful, light motor to launch it into the atmosphere and to sustain motion. The gas motor developed to meet the needs of the automobile required only further development to fit the special needs of aviation. As a matter of fact that development has been going on simultaneously in automobile, motor-cycle and aeroplane motors, and the leaders in mechanical flight might well contend that their share in the development of the gas engine is by no means small. Whether the chain of events thus outlined actually put the aeroplane in debt to the pneumatic tire, we shall leave to our readers to decide for themselves; but whatever the conclusion, the tracing of mechanical developments to imagined or real sources leads to some curious discoveries. One is forced to believe that many of the apparently trivial devices, in their infancy, have been the germs from which the most important developments have come.

* * *

THE COST OF SPECIAL TOOLS

Before deciding upon the design of special tools for manufacturing purposes, it is very important to compare the saving expected to result from the use of the new tool, with the cost of building the tool itself. A writer in MACHINERY in a recent series of articles on jigs and fixtures refers to this matter as follows: "Before planning the design of a tool, compare the cost of production, using present tools, with the expected cost of production using the tools to be made, and see that the cost of building the new tool is not in excess of the expected gain." This rule seems so simple and elementary that it is difficult to explain why it is so often disregarded.

As a concrete example of the meaning of the rule laid down above and the results produced when it is disregarded, the following occurrence in a prominent machine tool building shop may be of interest: A certain machine detail was produced in a slotting machine by means of a fixture costing $35. Ten pieces were produced per hour, the price per piece, including over-head expense, but not interest and depreciation of the fixture, being eight cents. The head tool-designer of the concern conceived the idea of a special fixture for producing these parts much more rapidly on a milling machine. Considerable experimenting, however, was necessary, and the total cost of the new fixture when completed was $518. This fixture made it possible to produce twenty pieces per hour, or double the number made by the old fixture. Consequently the price per piece is only four cents when the new fixture is used, interest and depreciation of the fixture itself not being considered, and a saving of four cents a piece is made possible. This would be a considerable saving if the fixture were constantly in use, but only 300 of these parts are required each year, so that the total saving resulting from the use of the fixture amounts to only $12 a year, and the fixture is in use for only fifteen hours during the whole year. Five per cent interest on $518 is $25.90, and if the manufacturing company expects this rate of interest, at least, on its investment, it will be seen that the use of the new fixture actually entails a loss of $13.90 per year, not considering depreciation and the fact that the labor necessary to build it could have been used to better advantage for other purposes. The depreciation may perhaps be considered as practically eliminated, because the fixture is used only for a few hours during the whole year.

This incident plainly illustrates the importance of determining closely the cost of a tool before it is designed and built, and the saving to be effected by its use. The designer, however, is not always directly responsible for the waste entailed when this cardinal principle of economical tool designing is overlooked. As is well known, the designer is often not permitted free access to the cost accounts, and this policy is largely responsible for some misdirected efforts of his energy. Often he does not know the present cost of doing certain work, and is given no opportunity to find out; yet he is expected to design tools for improved methods of performing the work. In such cases the designer cannot be held wholly responsible for inefficient and uneconomical results. That responsibility then falls on the man "higher up," who considers that anything relating to the economics of the concern should be strictly confined within the four walls of the cost-keeping department.

* * *

PRIZE FOR A SAFETY AUTOMOBILE CRANK

A French association for the prevention of accidents in industrial work has offered $300 in prizes for a crank or safety device for hoists, cranes, and all forms of lifting apparatus, and also for explosion motors, which shall, in the first case automatically stop the descent of the load, or in the second case, throw out of gear the driving action when not required. The invention remains the property of the competitor, who must himself be responsible for its due protection by patents. Drawings of competitive devices should be sent to the office of the Association des Industriels de France contre les Accidents du Travail, 4, Boulevard Saint-André, Paris, France. A non-return starting crank for gas engines, of simple design, was illustrated in the January, 1906, issue of MACHINERY; prospective competitors may be interested in studying this design in order to see what has already been done along these lines.

* * *

"John Brown, Practical Plumber," "James Smith, Practical Horseshoer," "Robert Jones, Practical Gunsmith," etc., are samples of signs found wherever we go that show a misunderstanding of the word "practical" or a deliberate misuse of the word for which there is no good excuse. If a man is a plumber, or a horseshoer or a gunsmith, he must be practical and follow practicable methods. Who ever heard of a theoretical plumber, or a horseshoer who shod horses by absent treatment, or a gunsmith who took dents out of gun barrels by suggestion? Drop the misused word "practical" from signs and see if they are not just as strong and comprehensive as before.

EFFICIENT SYSTEM FOR THE RAPID ASSEMBLY OF MOTOR CARS*

HAROLD WHITING SLAUSON†

From a mere corner in the machine shop in the days when the automobile was built in lots of but two or three at a time, the assembling room has grown to such an extent that, in many factories where the output is large, it occupies an entire floor of the main building, and has come to be considered as one of the three or four most important departments of a modern motor car factory. A corresponding increase in responsibility has attended the growth in size and importance of the assembling room, and today, unless well managed and equipped with the most up-to-date devices for the convenient and rapid handling of parts, it can easily "eat up" the profits on a whole year's output of low or medium-priced cars. Without requiring the services of an excessive number of men, it must take care of the parts from the machine shop and the parts-assembling room as they are turned out, and not allow a great number of finished pieces to accumulate at any time in the stock room. The work of assembling must also be done thoroughly, so that, when tested, the complete car need not be sent back for overhauling and readjustment of parts. In short, the assembling room must work in harmony with each of the other departments in doing its share toward producing a car of maximum quality at minimum cost of production—and that share is by no means small. But not alone are the best systems and business management, proper interior arrangement and most up-to-date devices necessary, but the highest class of skilled mechanics must be employed as well. A motor and transmission may be composed of the best of materials and have bestowed upon them the most skilled workmanship available, but unless they are placed together in the completed car with each shaft lined up, each bearing scraped and fitted and each gear in position to mesh properly, all this expensive material and labor may count for naught. The assembling room cannot, to any great extent, compensate for poor machining, but it *can* absolutely ruin the best products of the machine shop.

That the leading automobile manufacturers have been brought to a realization of the importance of the use of the best systems, equipment and labor in their assembling rooms is particularly well exemplified in the factory of the Chalmers-Detroit Motor Car Company at Detroit, Mich. Probably the most convincing proof of this statement will be found in the fact that, for the 3,000 complete cars turned out by this company last year, not more than 30 men were employed at any one time on the assembling room floor. More remarkable than this, however, is the high record established for a day's work. In ten hours, the 30 men in this department assembled 35 complete cars! Of course this does not include the assembling of the various small parts of the motor, transmission and rear axle, as these are taken care of in other departments, but when it is remembered that the chassis assembly *does* include the installation of all these parts in the frame, the adjustment of each to its new position, the attaching of all springs, wheels, running-boards, foot-rests, steering gear, and the wiring and piping of the motor, it will be realized that the system and equipment employed in this department of the Chalmers-Detroit factory must be perfect in every respect in order to turn out this amount of completed work.

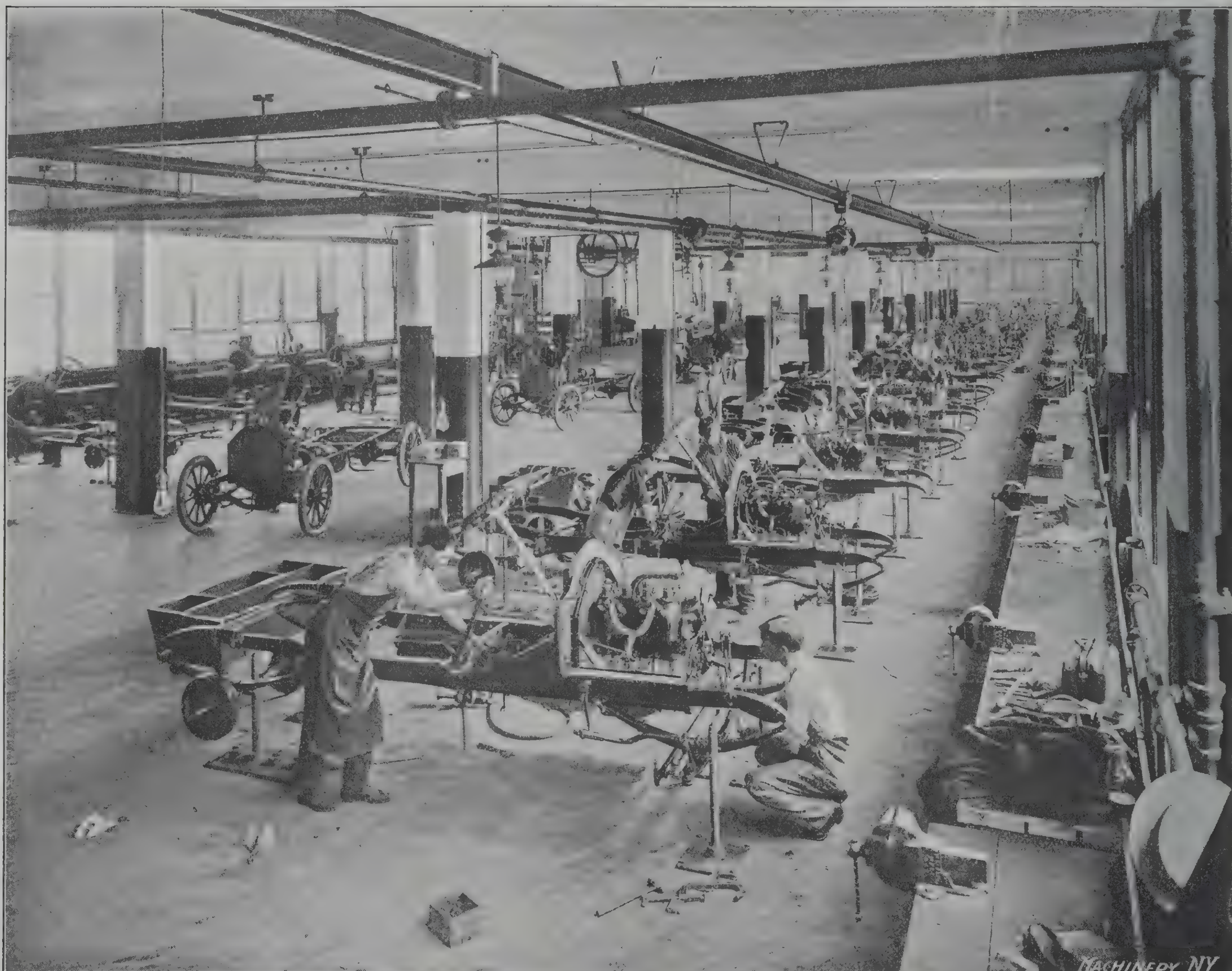


Fig. 1. View of the Assembling Room, showing Arrangement of Overhead Track and Differential Hoists; the Trucks, each of which holds the Parts for Two Cars; and the Adjustable Frame Supports

The headquarters of the assembling department may be said to lie in the finished stock room, which occupies a large section of the floor of the main factory on which the assembling room proper is located. To this finished stock room come all finished parts such as nuts, bolts, screws, front axles, springs, and wheels, and the previously assembled motors.

* For further information on this subject, see "Machines and Tools for Automobile Manufacture," June, 1909, and articles there referred to.
† Address: Box 27, Times Square Station, New York.

transmissions, steering gears, and rear axles. These are all classified and placed by themselves, the smaller parts being kept in bins which extend in long rows down one end of the room. Lists pasted in conspicuous places along these bins show the exact number of each size and kind of bolts, nuts and other pieces required for the various models of cars made here, and hand trucks having bodies divided into compartments are drawn down past the bins and filled with the necessary number of small parts for two cars. In the larger divisions of the truck box or body are placed the axles, steering gear, running boards, foot rests, and other bulky parts of the car. Each truck is filled with a sufficient number of the

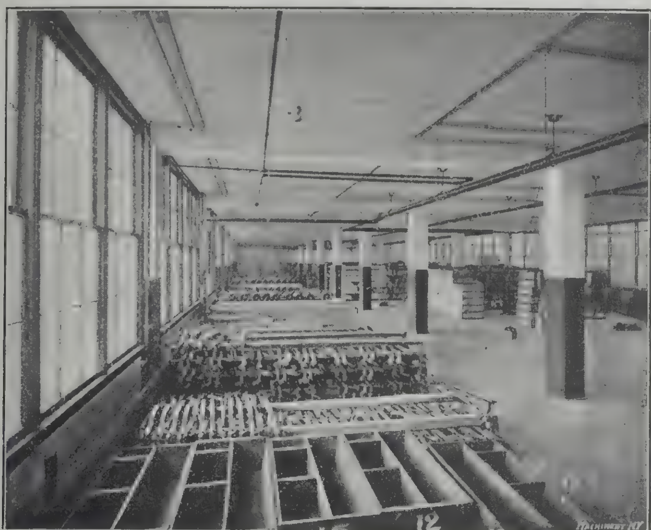


Fig. 2. View of Stock Room, showing Trucks in which Parts are taken to the Assembling Room, Assembled Parts, and Bins in which Smaller Parts are Stored

proper parts for the complete assembly of two cars and is then rolled into the assembling room, adjoining the stock room, and placed between two pressed steel frames which form the foundations, as it were, of the two chasses to be assembled. Having received the required number of parts of the proper kind, three men now devote their entire time to assembling the two chasses—and it is here that the advantages of "team work" are exhibited. Having become accustomed to this method of assembling, each man knows just what he is to do, and always has the other chassis at hand to which he can turn his attention when he is liable to interfere with the work of his two companions. It is highly specialized work, each team of three men devoting their whole time and energy to the installation and adjustment of the various parts of two cars until they are ready for the road test. As three men finish the first two chasses, another truck is brought in containing parts for two additional cars, and the team then devotes its attention to cars three and four. The motors are not included in the quota of parts comprising the truck load, but are carried in separately on differential hoists which travel on overhead tracks and pass in two lines down the sides of the assembling room in front of the two rows of chasses. When the frame is ready for the installation of its motor, the latter is lowered in place. This system renders each car independent of the stock room after the truck load of parts has been received, and the work bench, vise and kit of tools near every chassis reduce to a minimum the number of steps necessary to be taken by each workman.

The arrangement of the rests for holding the frames rigidly in place is very ingenious and entirely does away with the use of saw-horses or other movable and bulky supports. There are four of these supports for each frame, as shown in Fig. 1, and when not in use, one or all may be let down into the floor. Each of these supports consists merely of a vertical iron rod, bent at right angles at its upper end and forged into the shape of a hook. A corner of the frame rests on this horizontal portion of the rod, while the hooked-shaped ends of the two opposite supports prevent lateral motion in either direction. Each rod is supported by a pin passing through it at the proper distance from the end, which rests across the top of the base-plate which is bolted to the floor and through which the end of the rod passes. By giving a partial turn to the rod, the pin is allowed to pass through a slot in the base-plate, and the whole support is thus dropped until its top is flush with the floor. In order that the supports may accommodate themselves to various lengths of frames, the rear pair of every set of four base-plates is made with four sets of holes, in any of which the rods may be placed. The sets of supports are placed at such intervals along the floor that sufficient space between the frames is allowed to enable two teams of men to work on adjoining cars without interference. While it may seem a small matter, the facility with which these supports may be put in place, adjusted or removed from the floor, helps to make possible, in no uncertain degree, the record for the rapid assembly of cars of which this factory can boast.

Although not a part of the assembling room proper, the department in which the pressed-steel frames of channel-section are prepared for the chassis, has an important part in facilitating quick assembling. When the frames arrive at the factory, forty or fifty holes must be drilled for the various parts which are to be attached, such as the gear shift, brake levers and their supports, the motor, transmission, running boards, fenders, lamp brackets, springs, and the like. Most of these, with the exception of the motor and transmission, are riveted in place before the frames reach the assembling room. These operations are performed in the frame riveting room, which contains several unique and ingenious arrangements that, so far as efficiency is concerned, bring this department on a par with the assembling room. The frame is first placed on a set of supports similar to those used in the assembling room, except that a tension rod and turnbuckle connect both pair of rods for the purpose of holding the frame more rigidly in place. A single track over this set of supports carries a differential hoist, from which is suspended a large jig (see Fig. 3) containing a guide hole corresponding to every hole necessary to be drilled in the sub-frame, which carries the motor and transmission. This jig is clamped securely in place and the holes drilled by means of pneumatic drills connected to flexible piping. When all the

Fig. 3. Room in which the Frames are drilled and riveted by Pneumatic Tools

holes are drilled in this manner, the frame is removed to another set of supports a few feet distant where it is held rigidly in place in the same manner as that before described. Above this second set of supports is an oval track of the same length and width as the frame. From the traveler on this track is suspended a cable terminating in a single pulley through which passes a chain. On one end of this chain is a heavy, pneumatic riveter, which is counterbalanced by an iron weight attached to the other end of the chain. This enables the tool to be placed at any height desired without unnecessary exertion. A small forge (not shown in the illustration) in one corner of this room heats the rivets before they are driven into the frame. By means of the oval track and pulley, any vertical or horizontal plane bounded by the frame may be reached with the riveter, and four or five men

in this department are usually able to keep the assembling room supplied with the required number of frames. After being finished in this department, however, the frames in all cases are taken directly to the finished stock room, from which they are drawn out to the assembling room as needed. This stock room, in fact, acts as a sort of clearing house for the whole factory, and no part ever reaches the complete car until it has been inspected, checked and entered in the stock room records.

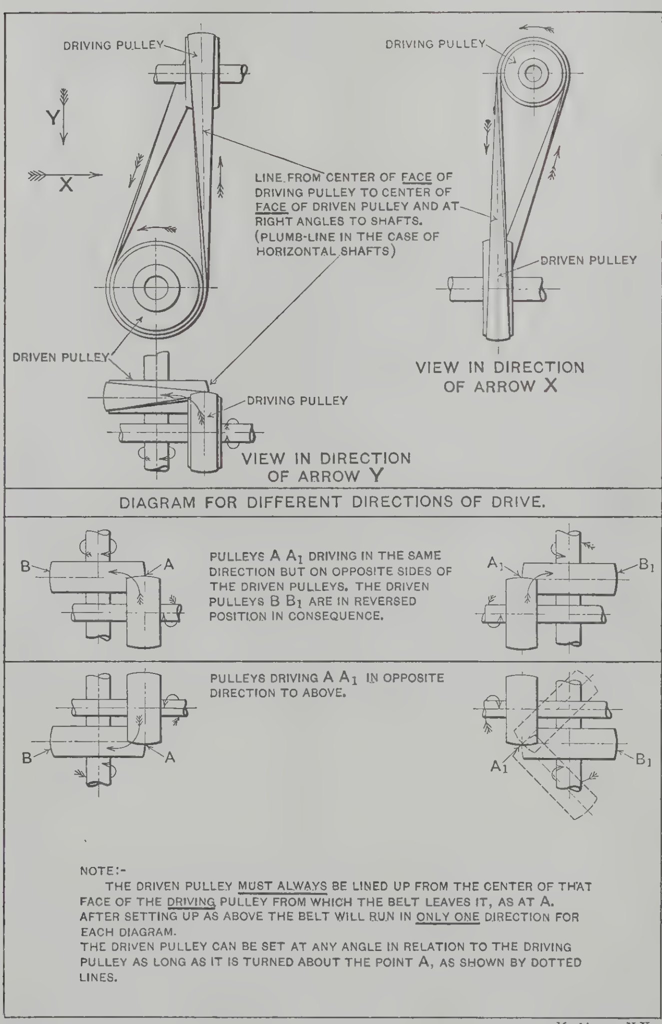
The keynote of this system is specialization. Every man knows what he has to do—and he does it. There is no overlapping of departments. It is scarcely ever necessary for the men in the assembling room to step into the stock room, and the men in the stock room are supposed to keep the men in the assembling department supplied with the necessary parts for the cars that have been ordered to be finished that day. Each team in the assembling room follows its two cars through until they are ready for the road test, and it is then easy to place the responsibility for any defect, where it belongs. When this system is supplemented with such labor and space saving devices as are used in the assembling and frame riveting rooms, and when, at the head of it all, is able, efficient and experienced management, one can begin to understand the conditions which allow the immense increase in production and the reduction in cost of the American-made motor car of today.

* * *

LOCATING ANGLE BELT DRIVES

GLASGOW

In answer to C. A. H.'s article in the August number, under the heading "What Would Jim Have Said," I submit herewith a data sheet of angular belt drives which was issued to



Locating Belt Drives when Shafts are not Parallel

the men here some twelve months ago. These diagrams show all the different positions of the pulleys for different directions of rotation of the shafts, and are also applicable to shafts in any position, vertical or horizontal.

ASSEMBLING MACHINE TOOL UNITS*

ALFRED SPANGENBERG†

In an article on "Elements of Assembling Operations" appearing in the September issue of MACHINERY, the writer laid down some fundamental principles relative to the methods and processes employed in manufacturing, and advanced the proposition that accurate drawings, accurate machine work and the use of jigs and gages are at the foundation of economical assembling. Interchangeability, standardization, and duplication in quantities were also discussed. The present

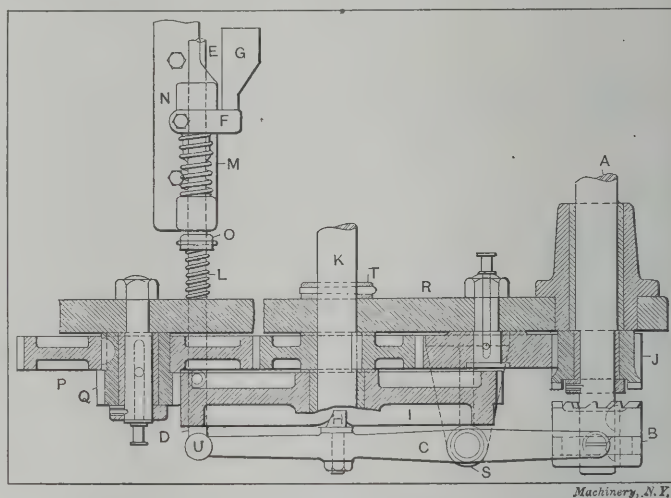


Fig. 1. Turret Lathe Indexing Mechanism to be assembled

article will deal with concrete examples illustrating the application of these principles in actual shop practice.

Assembling a Turret Lathe Indexing Mechanism

The turret lathe indexing mechanism shown in the line engraving Fig. 1 is presented to bring out clearly the necessity for analyzing the purpose of every part of a machine in order to machine and assemble the members so that they will function properly. In operation, the driving shaft *A* is constantly revolving in a certain direction. Keyed to this shaft is the sliding clutch member *B* operated by the forked lever *C*, link *D*, rod *E* and stop *F*. The dog *G* is bolted to the turret carriage and when the carriage is run back this dog strikes the stop *F*, thus withdrawing the indexing pin *H* from its slot in the index gear *I* and engaging the driven clutch member *J*. This starts the train of gears that revolves the turret by means of the worm shaft *K*, the worm-gear being bolted to the turret. An automatic knockout (not shown) stops the power traverse of the carriage the moment clutch *J* is engaged.

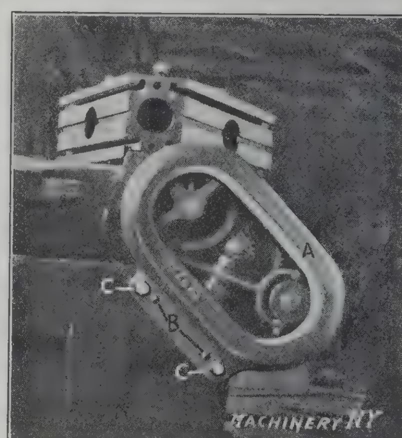


Fig. 2. Turret Lathe Indexing Mechanism shown in Detail in Fig. 1, Assembled

The turret continues to revolve until the carriage is run forward by throwing in the rapid power traverse mechanism which allows the indexing pin *H* to enter the slot in the index gear, and the turret stops revolving by virtue of the springs disengaging the clutch member *B*. The ratio of the back-gears is such that the index gear makes one revolution for each station on the turret. Spring *L* is for releasing the clutch and spring *M* keeps the stop *F* in position when the bracket *N* is moved along the bed in its T-slot. It is obvious that the springs should be as light as possible in order to avoid unnecessary wear on the indexing pin and face of the index gear and also to prevent a heavy pound when in

* For additional information on this subject, see MACHINERY, September, 1909, "Elements of Assembling Operations," and articles there referred to.

† Address: 951 W. Fifth St., Plainfield, N. J.

operation, but the springs must have sufficient power to always bring the index pin to the bottom of its slot in the index gear.

The length of the springs, their stiffness, and the position of the collar *O* on the rod are determined in the beginning by experiment, and when found to be correct, their dimensions are marked on the drawing so as to provide for standardization. To permit the use of light springs, it is absolutely essential that the clutch-operating members be fitted perfectly free so that the mechanism will index properly. The function of these members requires no rigidity in fit and the looseness desired is provided for by limits on the detail drawings, so that when the work, properly inspected, comes to the assembler no special fitting is required. As a general rule such parts receive little or no oil when the machine is in the hands of the operator, and if the parts are naturally stiff, trouble will arise. It must not be inferred that the writer is advocating such looseness in fits as to indicate poor workmanship, but many similar mechanisms have failed to work properly because of being too stiff, which shows lack of judgment and experience on the part of the assembler. The trouble in some cases, however, was due to the parts not being in proper alignment.

Before starting to describe any of the assembling operations, it will be well to bear in mind that while the description necessarily gives the operations in sequence, it is probable that in actual practice a number of different operations will be carried on at the same time, depending on the number of men working on the job. The gear plate and its cover, the latter being shown at *A*, Fig. 2, come to the assemblers with all the holes jig drilled and reamed except the taper dowel pin holes *B*. All the oil grooves are machine cut except those for the worm-shaft in the gear plate and cover.

Assuming that the turret lathe beds are in process, the operations of assembling the mechanism complete will include bench and vise work and also floor work, since some of the members are interdependent with others on the lathe bed. The bench work consists of assembling the three independent groups, *viz:* the back gear members *P* and *Q*, Fig. 1; the fork lever members, including the sliding clutch *B;* and the operating rod bracket members *D*, *E*, *F*, *M*, *N*, and *O*.

The floor work consists of lining up the gear plate *R* on the lathe bed and assembling the entire mechanism. The operation of lining up is accomplished by means of two special arbors, one of which fits the worm-shaft bearings in the turret carriage and the other fits the holes in the operating rod bracket *N*, the arbors being long enough to pass through corresponding holes in the gear plate. The arbors are placed in position, with the turret carriage and operating rod bracket moved as close to the gear plate as possible, the latter now being bolted to the lathe bed. For obvious reasons the lining up is done with special reference to the operating rod and worm-shaft holes, since the adjacent bearing on the bed for the driving shaft *A* is some four feet away from that on the gear plate. Alignment of the driving shaft is tested by surface gage measurements taken from the top and side of the V on the bed, a few thousandths "off" being permissible.

Referring to Fig. 2, the bolt holes *C* have 1/32 inch clearance in the gear plate to allow it to be shifted slightly, and when properly set, the taper dowel pin holes are drilled in the bed by means of a pneumatic drill, then hand reamed, and the taper pins driven in place. The subsequent operations consist of assembling the shafts, studs and gears in their places, the process being so simple that no explanation is necessary. Next, the operating rod bracket members are put in place and then, after setting the index gear, the fork lever bracket *S* (Fig. 1), with its members already assembled, is bolted on and the connection with the link *D* made by inserting its pin.

Setting the index gear is accomplished in the following manner: The worm-shaft is set so that one-quarter of its total amount of back-lash is on the driving side, *i. e.*, if a line is placed on the periphery of collar *T*, and the total amount of backlash in the worm between its bearings in the turret carriage allows the line on this collar to travel ½ inch, then the worm-shaft is turned so that the line on collar *T* moves back ⅛ inch from the side towards which the shaft revolves when in operation. Now, with the fork lever members in place, excepting the pin *U*, the index gear is set so that when the indexing pin *H* is in position in its slot, the pin *U* will enter freely in its holes by virtue of their being in line.

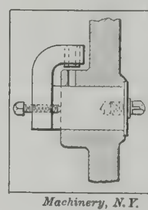


Fig. 4. Jig for Set-screw Holes

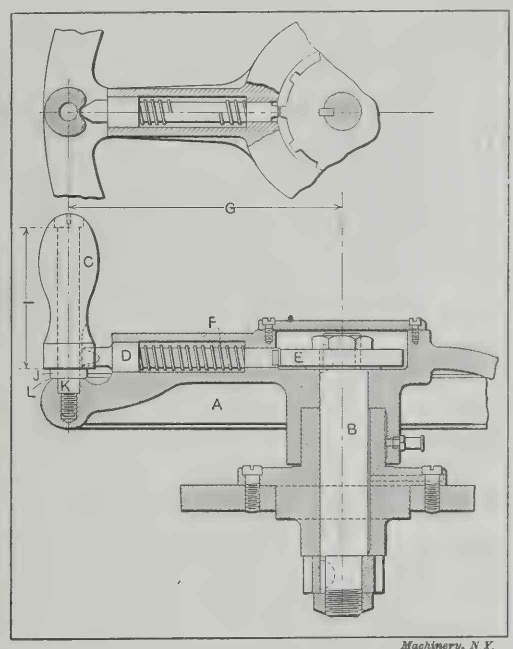


Fig. 5. Example of Device Difficult to assemble if Parts are not made in Jigs insuring Interchangeability

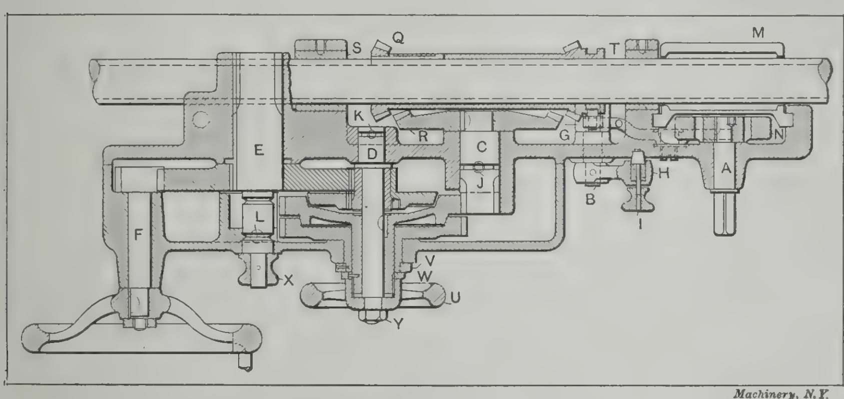


Fig. 3. Engine Lathe Apron to be assembled

The setting of the index gear to accomplish this is done by keeping the teeth of the index gear in mesh with its pinion and changing the teeth in the large back gear *P* in relation to those in its driving gear. Smaller adjustment of the index gear is obtained in this manner than by changing its teeth in relation to the teeth on the pinion *Q*, which fact is due to the ratio of the gears. Bolting on the cover is the final operation.

Assembling an Engine Lathe Apron

The engine lathe apron illustrated in the line engraving Fig. 3 is presented to show how machine tool units of this character are assembled on a manufacturing basis. Lathe makers, as a rule, build their lathe parts such as head-stocks, tail-stocks, rests and aprons in large lots so as to take advantage of the economy to be gained from carrying on the same operations on a large number of similar pieces in succession, both in machining and assembling; this has already been referred to.

It will be observed that the various shaft members are entirely independent of each other as far as their separate assembling is concerned, so that it is highly advisable to group these units to permit their being assembled at the bench as opportunity offers, which in most cases is while the aprons and covers are being bored and drilled. There are six distinct groups consisting, respectively, of the shafts *A* to *F* and their members. The assembling of these groups at the bench merely involves ordinary vise work so that little explanation is necessary. It will be well to state here that

when these parts are machined, particular attention is paid to the inspection of the length over shoulders, so that when the groups are assembled and put in place in the apron and cover no occasion will arise for any fitting or adjusting.

The method of testing shoulders on the friction gear shaft members, group *D*, in Fig. 3, is clearly shown at the right in Fig. 6; *A* represents a surface plate having a hole to receive the bearing end of the shaft. The double friction gear *B* when in its place in the apron has a lateral movement of 1/16 inch, the movement being controlled by the hand-wheel *C*. The dimension *D*, when all the friction surfaces are tight, being known, it is tested with a surface gage as indicated. The dimensions *E* and *F* are tested with ordinary length gages. A running fit is allowed on all shoulders while the length of the bearings in the apron and cover are made standard.

At the left in Fig. 6 is shown a jig for locating the levers *G* and *H* (Fig. 3) at the proper angle on their shaft while drilling and reaming the taper pin holes. This operation is done on a sensitive drill press to permit machine reaming.

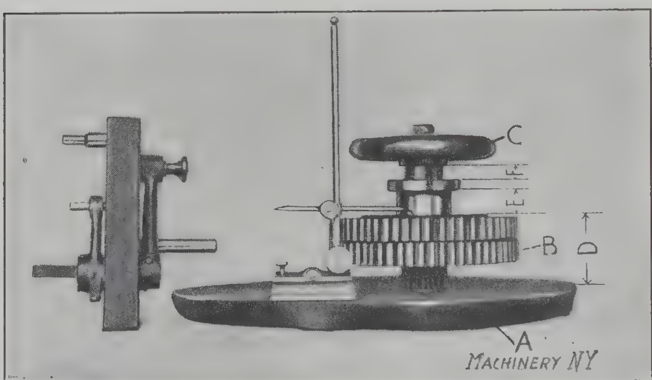


Fig. 6. Special Devices used in Assembling the Lathe Apron shown in Fig. 3

The jig is shown standing on end for the purpose of illustration, and its being used for two different sizes of levers accounts for the extra locating pins.

Referring now to Fig. 7, the method of testing the lead-screw nuts *M*, cam *N*, safety lever *O*, trunion lever *G* and the bevel gears *Q* and *R* is clearly indicated, the reference letters corresponding to those in Fig. 3. At *D* is shown a testing fixture in the form of an apron casting which is bored and reamed in the apron jig and is provided with supports at the back for holding it in the position shown. A short arbor representing the lead-screw is placed in the bearings *S* and *J* and holds the double bevel pinion *Q* (not in place in the engraving) in position.

It will be observed that the function of the safety lever is to prevent the double bevel pinion and the lead-screw nuts from accidentally becoming engaged at the same time, which

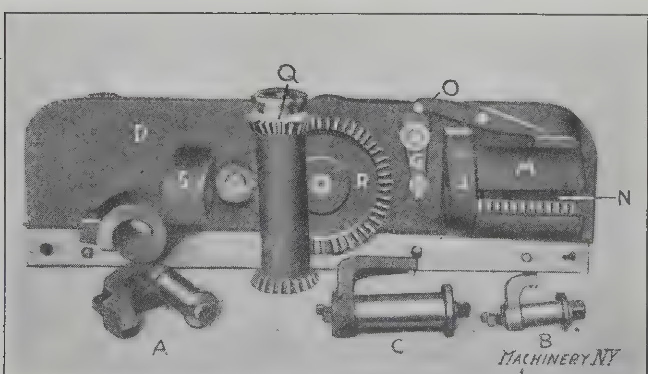


Fig. 7. Testing Fixture for Parts of Lathe Apron

would cause a breakage. Special milling fixtures are provided for milling the ends of the safety lever and the slot in cam *N* and lever *G*.

A babbitting jig is provided for the lead-screw nuts so that it is not necessary to babbitt them in place on a threaded arbor. The cam pin holes in the nuts are jig drilled. This has the advantage of making the nuts interchangeable besides avoiding the necessity for carrying hot babbitt any distance through the shop. If any of the members fail to function properly, the faulty member is, of course, replaced.

All the drilling, boring, and machine reaming on the aprons and covers is completed in the drilling department except the holes for the oil pipe (not shown) spring pin *I* and set-screws *J* and *K* (Fig. 3). Small holes such as these can be

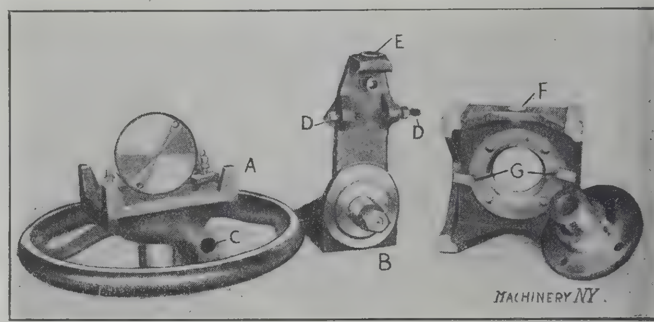


Fig. 8. Jigs for Drilling Parts of Device shown in Fig. 5

drilled cheaper with an air drill, due to the fact that the oil holes are comparatively short and are on an angle, while the spring pin hole *I* cannot be drilled until some of the assembling operations are completed.

When the aprons and covers are received in the assembling department, they are placed on special trestles for convenience in assembling. The castings are now painted, all of the chipping and cleaning having been done in the foundry. The next operation consists in drilling the oil holes and the holes for the set-screws *J* and *K*. Jigs for drilling the latter are shown at *A* and *B* in Fig. 7. Jig *C* drills the spring pin hole *L* in the apron cover which is machine drilled. The hole is at right angles to the top of the cover and the jig is easily set up as is evident by referring to Fig. 4 which shows jig *B* in position in the apron. It will be observed that these jigs permit the groove in the shafts to be cut standard size and the shafts made interchangeable.

After chipping the oil grooves and tapping the screw holes, the covers are bolted on for the purpose of hand reaming

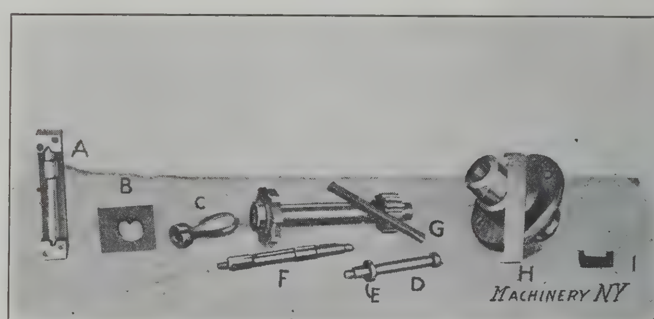


Fig. 9. Gages for Testing the Parts of the Device shown in Fig. 5

all shaft holes to standard size. The covers are then removed and the aprons laid face down for the purpose of fitting the lead-screw nuts *M* (Figs. 3 and 7). The nuts, babbitting jig and grinding ways in the apron being machined to gage, it is only necessary to smooth the surfaces on the nuts and apron to make the nuts slide freely.

When all of the members shown in Fig. 7 fitting the back of the apron have been fitted and tested at the bench, they are put in place in the aprons. In performing this operation the corresponding pieces are placed in each apron in succession. With the lead-screw nuts closed by means of the cam, a special tap, mounted on an arbor fitting the lead-screw bearings, is run through the nuts to clean out the threads.

The aprons are now turned face up for the purpose of fitting the oil pipes and drilling the holes for spring pin *I* (Fig. 3). There are three holes to be drilled in the apron for this pin to enter, one for the central position of lever *H* which operates the double bevel pinion, and one for each extreme position. A special center punch which fits the hole in lever *H* is used to lay out these. The central position is determined by the safety lever fitting into the notch in lever *G*; while the bevel pinion mounted on an arbor and alternately brought into mesh with the bevel gear, determines the extreme positions. After the holes are drilled by means

of a pneumatic drill, a reamer is substituted for the center punch in lever *H* and the holes reamed taper to fit the spring pin *I*. A collar on the reamer acts as a depth gage. It would, of course, be possible to drill these holes in the jig that drills and bores the aprons, but this is hardly deemed advisable as there are a number of elements that must be taken into consideration, an error in any one of which would prevent the bevel gears from meshing properly. Placing the spring pins *I* in position completes the work on the feed reversing mechanism.

The rack pinions *E* and gears are now put in place, then the friction gear shafts *D* and their members, except the hand-wheel *U* and collars *V* and *W*. After driving in the studs for the intermediate cross-feed gears (not shown because of the sectional view) the aprons are ready to receive the covers.

Work on the covers consists in placing the hand-wheel pinions and hand-wheel members in position and fitting the rack pinion spring pin members after which the covers are bolted onto the aprons. The rack pinion knob *X* is now put on and then the collars *V* and *W* are fastened onto the friction gears as shown in the line engraving Fig. 3. Screwing on the hand-wheel *U* and nut *Y* completes the apron and it is ready to be sent to the store room.

Assembling an Automatically-releasing Hand-wheel Mechanism

Unless jigs and gages are used in the machining process, the peculiar conditions encountered in assembling a mechanism such as shown in the line engraving Fig. 5 would call for a high degree of skill on the part of the assembler besides involving excessive cost. The half-tones Figs. 8 and 9 illustrate a set of jigs and gages for producing this mechanism, which enables the assembling to be done without any filing or fitting, the object being to illustrate that *interchangeable* manufacture is really *economical* manufacture.

It will be seen that the function of the device is to automatically engage and disengage the hand-wheel member *A* with its shaft *B*, the action being as follows: Turning the hand-wheel in either direction by means of the handle *C*, so that the latter does not rotate in the hand, engages the pawl *D* with the ratchet *E* which is keyed to the shaft *B*; on releasing the handle, spring *F* disengages the pawl.

The requirements are that the handle and pawl must work perfectly free so that no effort to grip the handle hard will be necessary; the axis of the handle and pawl must intersect so that each cam face will work equally well; when the pawl is fully engaged with the ratchet, the handle end of the pawl must still be on the cam face of the handle; the contour of the cam, length of the pawl, diameter of ratchet and center distance *G* must be within close limits. Referring to Fig. 8, *A* is a jig for drilling the hand-wheel cover and its screw holes in the hand-wheel. The jig is shown in position for drilling the latter, being located in the counterbore of the hand-wheel. Resting on top of the jig is the hand-wheel cover which fits into the recess shown and is held by the two straps and bolts. The hand-wheel and its cover are, of course, drilled separately.

At *B*, in the same figure, is shown a jig for drilling the handle stud hole and the pawl hole *C*. The hand-wheel is located on a stud through its bore, and clamped to the jig by passing a bolt through the stud, this bolt being provided with a split washer on the end. To bring the pawl hole central with its hub, two set-screws are provided at *D* which hold the hand-wheel in position while being drilled by clamping against the sides of the spoke. The jig is fastened on the edge of the drill press table, so that the table does not interfere with the wheel. The vertical hole, with the drill guided by bushing *E*, is now drilled and reamed in all the hand-wheels, this hole being the pawl hole. For drilling and reaming the small diameter, a long bushing is used in the large diameter of the hole to guide the tools. When this hole is drilled, the jig is then clamped to the side of the box table and the hole for the handle stud is drilled in all the wheels.

The jig shown at *F* in the same engraving is for drilling the shaft bearing which is seen to the right. The hub on the bearing fits into the jig, the straps *G* holding the work in place. Both this jig and the one at *A* are provided with complete sets of clearance and tap bushings so as to permit their being used on a multiple spindle drilling machine.

In Fig. 9 will be seen a set of gages for testing the component parts of the mechanism shown in Fig. 5. Gage *A* is for testing the length of the pawl which is shown in position in the gage. The ends of the pawl are milled with forming cutters. At *B* is shown a gage for testing the cam surface on the handle *C*. This cam is also milled with a forming cutter and when milled to the proper depth will just pass through the gage. The gage *D* is used to test the handle for length *I* (Fig. 5), the collar *J*, the depth of counterbore *K*. This gage represents a standard handle stud except that it is provided with a groove to fit the U-shaped collar *E* which is of the same diameter and thickness as the collar *J* in Fig. 5. To test the handle, the gage is inserted into the hole and the U-collars slipped into the groove; the collar *J* is tested for thickness by fitting the groove in the gage; to test the depth of the counterbore *K*, the gage is screwed into the hand-wheel and the collar *E* tried as before.

The tool shown at *F* is the counterbore used in connection with jig *B*, Fig. 8, for finishing the counterbore *K* and surface *L* in Fig. 5. At *G*, Fig. 9, is a length gage for the shoulders on the hand-wheel shaft against which the gage is seen resting. In the same engraving, *H* is a gage for testing the length through the bearing hole, while to the extreme right at *I* is shown a length gage for the hand-wheel shaft hole.

It will be observed that all of these gages, with one exception, that of the cam gage *B*, are length gages. Their use was found imperative for interchangeable work. This is due to the fact that errors in length are far more likely to occur and cause trouble in assembling than errors in diameter. All of the essential measurements of diameter on the component parts of the mechanism shown in Fig. 5, *i. e.*, the running and driving fits, are tested with ordinary limit and plug gages, while the threaded members are tested with male and female thread gages.

In assembling the mechanism, the pawl, its spring, and the handle members are first assembled. After fitting the Woodruff keys and the shaft members, the ratchet wheel is removed for the purpose of assembling the bearing and hand-wheel. The ratchet wheel is then replaced and the nut screwed down tightly with a socket wrench, the shaft being held from turning by engaging the pawl. Fastening on the cover and screwing in the oil cup finish the assembling operations. There is no adjusting or fitting to be done since the proper allowances for all fits are provided for on the detail drawings and the accuracy of the machine work is insured by a thorough system of inspection. Thus it will be seen that the work of assembling in this case merely consists in combining the separate elements in their logical order.

Summary of Principles of Assembling Operations

Summarizing the principles referred to in the previous discussion, we may state the following rules as being the main points to be considered in assembling work.

1. To secure economical results we must have accurate drawings, accurate machine work, and use jigs and gages.
2. The use of limits on detail drawings is valuable especially when supplemented with a thorough system of inspection.
3. Inspection, both in the machine and assembling departments, is absolutely necessary.
4. Before assembling any part of a machine, its function should be thoroughly understood in order to have the parts work properly and to avoid any unnecessary refinement.
5. Study carefully the question of rigidity in fits.
6. Plan quick and efficient methods of lining up.
7. Always follow the drawings. In no case should deviations be permitted.
8. Anticipate any extra chipping for clearance that may be necessary, and so avoid having to take the work apart.
9. Analyze the elements carefully, and see if it will not pay to substitute the machining process on pieces that are sometimes fitted by hand.
10. Standardization is one of the cardinal princples of economical assembling. Therefore, do not leave stock for adjustment when the pieces can be machined to standard size.

11. Provide for the duplication of parts in quantities so as to take advantage of the saving to be gained from performing the same operation on a number of pieces in succession.

12. Separate the assembling operations for any particular job so as to provide for a subdivision of labor.

13. Follow the unit system of assembling in order to permit a large number of workmen to be employed on a job.

14. The operations involved in assembling the units should be separated from the erecting process.

15. All chipping should be done before the parts are scraped.

16. Where it would be necessary to take the work apart to line up the brackets or bearings, perform the lining-up operation first.

17. Plan methods and processes so that the work can be assembled with the least amount of handling.

18. Provide ample handling facilities.

19. Make the laborious operations in scraping as easy as possible by providing efficient pulling devices.

20. Before sending the units to store or to the erectors see that the operations are completed as far as possible.

* * *

FORMULAS FOR CONE CLUTCHES*

There appears to be considerable misunderstanding, or perhaps rather, lack of understanding, of the formulas for cone clutches. A number of formulas are given in various handbooks and treatises on design, but at first sight they do not agree, and if the designer has not deduced any of the formulas for himself, he will naturally doubt the source from which he obtains them because of finding discrepancy between final results. However, the various authorities in general give correct formulas, and the difficulty met is caused by the fact that in cone clutch design different formulas are developed according to whether the clutch surfaces are considered to engage with or without some slip. In the following a set of formulas are deduced for both conditions, and a summary of these formulas is given in the accompanying Data Sheet Supplement:

Assume that:

H.P. = horse-power transmitted,

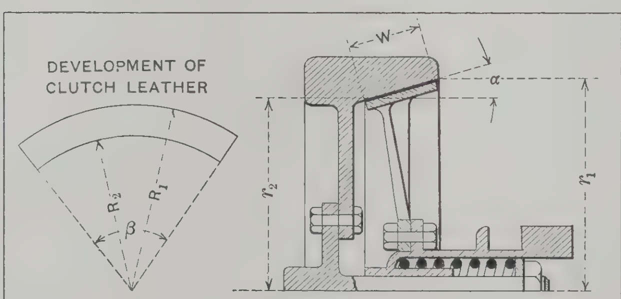


Fig. 1. Diagram of Cone Clutch

N = revolutions of crank-shaft per minute,
r = mean radius of friction cone, in inches,
r_1 = large radius of friction cone, in inches,
r_2 = small radius of friction cone, in inches,
R_1 = outside radius of leather band, in inches,
R_2 = inside radius of leather band, in inches,
v = velocity of a point at distance r from the center, in feet per minute,
F = tangential force acting at radius r, in pounds,
P_n = total normal pressure between cone surfaces, in pounds.
P_s = spring pressure, in pounds,
α = angle of clutch surface with axis of shaft = 7 to 13 degrees,
β = included angle of clutch leather, when developed,
f = coefficient of friction = 0.20 to 0.25 for greasy leather on iron,
p = allowable pressure per square inch of leather band = 7 to 8 pounds,
W = width of clutch leather, in inches.

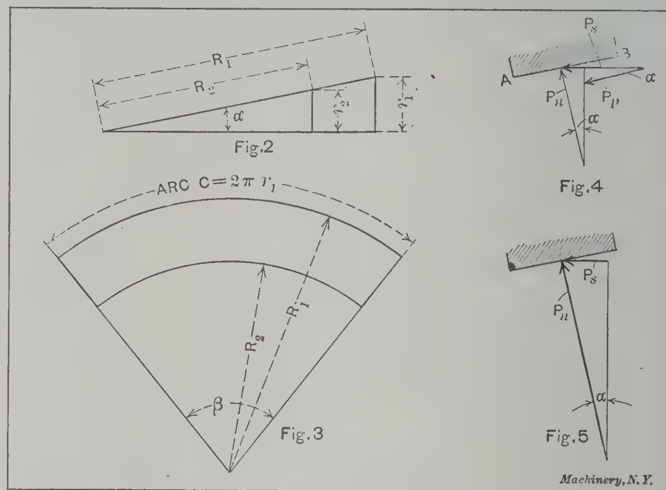
* With Data Sheet Supplement.

The relation between the outside and inside radii R_1 and R_2 of the clutch leather for covering the friction surface and the radii r_1 and r_2 of the friction cone are expressed by the following formulas, the deduction of which are clearly seen from Fig. 2.

$$R_1 = \frac{r_1}{\sin \alpha}$$

$$R_2 = \frac{r_2}{\sin \alpha}$$

The included angle β of the developed clutch leather (see Fig. 3) is found as follows: The length of the outside arc of the developed clutch leather surface equals the largest circumference of the cone clutch, or arc $C = 2\pi r_1$. (See Figs.



Figs. 2 to 5. Diagrams for Deducing Formulas for Cone Clutches

1 and 3.) Angle β is to 360 degrees as arc C is to the whole circumference of the circle having R_1 for radius. Therefore,

$$\frac{\beta}{360} = \frac{2\pi r_1}{2\pi R_1} = \frac{r_1}{R_1}.$$

But it has already been shown that $R_1 = \frac{r_1}{\sin \alpha}$, or $r_1 = R_1 \times \sin \alpha$, and therefore

$$\frac{\beta}{360} = \frac{R_1 \times \sin \alpha}{R_1} = \sin \alpha, \text{ or } \beta = \sin \alpha \times 360.$$

It is obvious that the mean radius r of the friction cone equals the arithmetic mean of the largest and smallest cone radii, or

$$r = \frac{r_1 + r_2}{2}$$

The velocity v of a point on the friction cone at a distance r from the center is found by the well-known formula

$$v = 2\pi r N$$

in which v and r are supposed to be measured in the same units. If v is in feet, and r in inches, the formula takes the form

$$v = \frac{2\pi r N}{12}$$

The tangential force acting at radius r, in pounds, is found by the formula

$$F = \frac{\text{H.P.} \times 33{,}000}{v}$$

which is deduced directly from the familiar formula for horse-power when the torque is given in foot-pounds.

If the width of the clutch surface is W, the area of this surface is $W \times 2\pi r$. The total pressure on the surface, P_n, must equal the pressure per square inch multiplied by the area, or

$$P_n = W \times 2\pi r p.$$

From this we deduce the formula

$$W = \frac{P_n}{2\pi r p}.$$

The horse-power transmitted equals

$$\text{H.P.} = \frac{P_n f \times 2\pi r \times N}{12 \times 33{,}000}$$

in which r is given in inches. By inserting the value of π in this formula, and dividing numerator and denominator in the fraction by 2π, we get

$$\text{H.P.} = \frac{P_n f r N}{63{,}025}$$

In Fig. 4 let it be assumed that the clutch surfaces engage without slip. Assume further that the spring pressure is represented by line P_s, the pressure normal to the clutch surface AB by P_n, and the force tending to bring the clutch surfaces in closer engagement by P_p; this last force, of course, is parallel to AB. The force P_s is partly used for producing the normal pressure P_n and partly used for bringing the clutch surfaces in closer contact; consequently

$P_s = P_n \times \sin\alpha + P_p \times \cos\alpha$.

But $P_p = P_n \times f$.

Therefore

$P_s = P_n(\sin\alpha + f\cos\alpha)$

$$\text{and } P_n = \frac{P_s}{\sin\alpha + f\cos\alpha}$$

If we substitute this value of P_n in the horse-power formula just deduced, we have

$$\text{H.P.} = \frac{P_s f r N}{63{,}025\,(\sin\alpha + f\cos\alpha)}$$

Transposing, we get

$$P_s = \frac{\text{H.P.} \times 63{,}025\,(\sin\alpha + f\cos\alpha)}{f r N}$$

If we assume that there is some slip between the clutch surfaces, the force P_p in Fig. 4 becomes zero, and the whole of force P_s is used to produce normal pressure, as shown in Fig. 5. Then

$$P_n = \frac{P_s}{\sin\alpha}$$

and, substituting in the horse-power formula, as before, we have

$$\text{H.P.} = \frac{P_s f r N}{63{,}025 \sin\alpha}$$

and

$$P_s = \frac{\text{H.P.} \times 63{,}025 \sin\alpha}{f r N}$$

The most important of these formulas have been collected in compact form and are given without their deductions in the Data Sheet Supplement. They will be found very convenient for ready reference when designing cone clutches or checking designs already made.

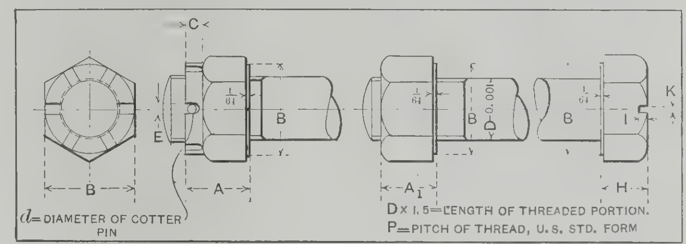
* * *

The export of automobiles from France, which declined in 1908, has shown a slight increase during the first months of 1909. During the first three months of the year 1907 France exported automobiles valued at approximately $10,300,000. During the first three months of 1908 the exports declined so that the total value of automobiles exported was only $8,700,000. During the first three months of the current year the exports again rose to $9,500,000. England is the best customer of France for automobiles, more than forty per cent of the exports being to Great Britain. The exports of automobiles to the United States are decreasing so that during the first three months of 1909 automobiles to a value of only slightly more than $500,000 were imported, as compared with over $800,000 in 1908, and nearly $800,000 in 1907. The Argentine Republic appears to offer a good field for the automobile trade, the French exports to that country during the first three montns of the current year amounting to over $750 000. The imports of automobiles to France are almost negligible when compared with the exports. During the first three months in 1909 the total value of imported automobiles amounted to about $400,000, the United States supplying cars to a value of only $16,000. Germany and Italy supply the largest proportion of cars imported by France.

STANDARD AUTOMOBILE PARTS ADOPTED BY THE A. L. A. M.*

The Association of Licensed Automobile Manufacturers (A. L. A. M.) has, from time to time, standardized some parts which occur in automobile design, and which are likely to require frequent replacement or repairs. The most important of the standards adopted by the association undoubtedly are the standards for fine pitch threads, screws, castle and plain nuts, which were published in MACHINERY'S Data Sheet No. 63, accompanying the November, 1906, issue. In this issue an editorial was also published entitled "Automobile Fine Screw Threads" in which the new standard for screw threads was discussed. A table condensed from the Data Sheet mentioned, giving all the required dimensions, is published herewith.

STANDARD HEXAGON-HEAD SCREWS, CASTLE AND PLAIN NUTS



Machinery, N.Y.

D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1
P	28	24	24	20	20	18	18	16	16	14	14
A	9/32	21/64	13/32	29/64	9/16	39/64	23/32	49/64	13/16	29/32	1
A_1	7/32	17/64	21/64	3/8	7/16	31/64	35/64	19/32	21/32	49/64	7/8
B	3/8	1/2	9/16	11/16	3/4	7/8	15/16	1	1 1/8	1 1/4	1 7/16
C	3/32	3/32	1/8	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4
E	5/64	5/64	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32
H	3/16	15/64	9/32	21/64	3/8	27/64	15/32	33/64	9/16	21/32	3/4
I	3/32	7/64	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8
K	1/16	1/16	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32
d	1/16	1/16	3/32	3/32	3/32	1/8	1/8	1/8	1/8	1/8	1/8

Since the adoption of the standard A. L. A. M. thread, the association has adopted a standard spark plug, the dimensions and special specifications of which are given in the accompanying supplement. Standard designs for adjustable and solid yoke and eye rod ends have also been adopted, dimensions for which are also given in the supplement, together with dimensions for the pins and washers used with these rods.

The horse-power of automobile engines has always been more or less indefinitely expressed, and until recently there has been no formula giving a satisfactory relation between the horse-power and the diameter of the engine cylinder and the piston speed. The association, therefore, some time ago adopted a standard horse-power formula, assuming a piston speed of 1,000 feet per minute. According to this formula, if

D = diameter of cylinder, and

N = number of cylinders,

$$\text{then H.P.} = \frac{D^2 \times N}{2.5}.$$

The table in the supplement giving horse-power of automobile engines has been calculated from this formula for engines having one, two, four and six cylinders, with the diameter of the cylinder varying from 2½ to 6 inches. It will be understood, of course, that this formula gives only approximate results, as the actual horse-power of any one automobile engine could not be expressed by so simple or general a formula. However, this formula is of great assistance in estimating in a general way the probable horse-power of an automobile engine.

* * *

A commission has been at work for the last two years in Sweden preparing a new schedule for import duties. The new tariff, which has not yet been adopted, proposes increases in the import duties imposed on machinery, the avowed purpose being to protect home industries.

* With Data Sheet Supplement.

TREATMENT OF GEARS FOR AUTOMOBILE MOTORS AND TRANSMISSIONS

HAROLD WHITING SLAUSON*

There is probably no part of an automobile that is subjected to more use or greater abuse than the transmission. Carrying as it does practically all of the power developed by the motor, and, receiving at the hands of a careless driver the strains imparted by a suddenly applied load or a too rapid shifting of the speeds, it is small wonder that the gears of the transmission must be made of the highest grade of materials, and that the care and workmanship bestowed upon each must be of the best. The ordinary automobile transmission consists of a series of different sizes of spur gears mounted on two parallel shafts with means for sliding the gears on one shaft into mesh with those on the other, as desired. In this manner various speed ratios are transmitted from the motor to the main driving shaft, although on the majority of automobiles the high speed drives the car direct, without the interposition of any of the gears of the transmission.

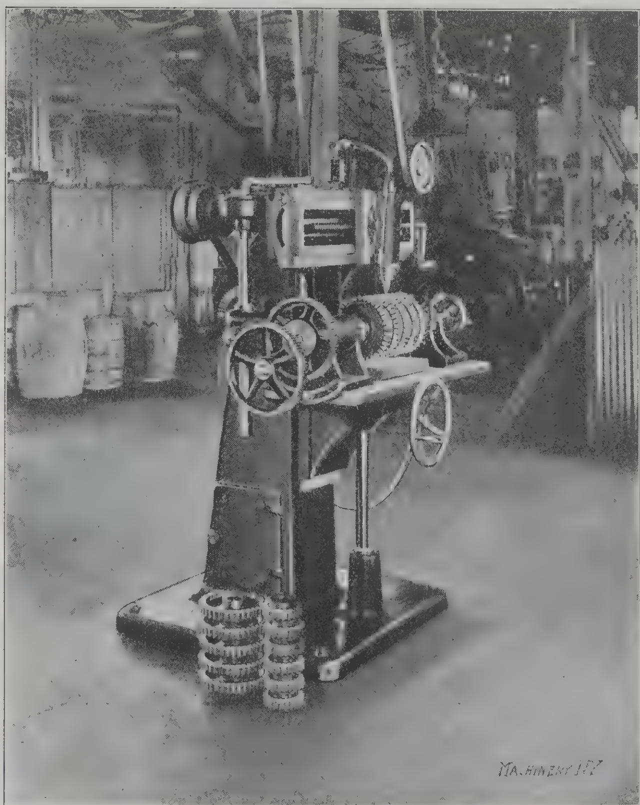


Fig. 1. Chamfering the Teeth of Spur Gears in the Winton Factory

As a saving in weight is an important factor to be considered in the design of a transmission, the gears must be made as small as possible and yet be sufficiently strong to carry suddenly-applied loads with no attendant danger of breaking. Owing to the methods by which the speeds are changed, and the clashing and "bruising" which take place when the gears are shifted, the transmission must also be made of a material which is hard as well as tough. Different kinds of steel have been used and each has been treated by various methods in an effort to discover the perfect gear material, but although this is yet to be found, the transmission of a modern, well-made automobile, when intelligently handled, will last nearly as long as the car itself. Of the various kinds of carbon steel which have been employed for transmission gears, nickel, chrome-nickel and silico-manganese seem to have more adherents among the leading builders than any other materials. In most factories the gears are case-hardened after being cut, and in this manner the combination of toughness with the desired hard surface is obtained. Gears which have been treated in this way have been taken out of cars after having been run many thousands of miles, and in some instances, the original tool marks on the faces of the teeth were still visible.

Methods employed for cutting gears in automobile factories do not differ in any essential features from those used in any well-equipped machine shop or manufacturing concern. Most of the automobile makers purchase their transmission gear blanks outside and cut and finish them in the factory. Many of these blanks of special steel are imported from France, but a few of the leading factories have laboratories of their own in which experiments on high-quality materials for transmission purposes are continually in progress. Six or seven spur gear blanks of the same size are generally placed on the mandrel of the cutter at once. A continuous cut extending throughout the width of all of these blanks is then taken for each tooth, and in this manner six or seven gears are finished at once and are made absolutely uniform.

After the teeth have been cut, the gears are taken to the heat treating room to be case-hardened. In the Middle West, and a few other sections, many of the case-hardening ovens are heated by natural gas obtained from near-by wells. In the Maxwell factory, at Newcastle, Ind., a special machine has been installed for the manufacture of gas from "distillate"—a hydro-carbon obtained from the oil refineries. This machine is set up in the power house connected with the factory, and the gas is stored in a tank located in the same building. It is conducted from here to the heat-treating ovens in which it is used for case-hardening, tempering and annealing. Still another method for obtaining heat for the ovens is in use at the Ford factory, in Detroit. Petroleum, or crude oil, is vaporized and forced by air pressure into a series of special burners located under the ovens. By regulating the amount of air or vapor or both, the ovens can be kept at a uniform temperature, or the amount of heat generated may be varied at will between almost any limits. The temperatures of the ovens are indicated by an electric pyrometer connected with each, and pieces to be case-hardened are kept at a heat of 1,600 degrees F. for a length of time which depends on the depth below the surface to which it is desired to carry the treatment.

In several factories the final operation bestowed upon the gear, before assembly in the transmission or the motor, is the sand blast which serves to scour off any roughness or stains which may have been left on the surface during the cutting or the heat treatment. In the National factory, at Indianapolis, this operation is conducted in a small building separated from the remainder of the shop. The sand is kept in a bin in one corner and is sucked up by a centrifugal blower and forced by the air pressure through a pipe which terminates in a nozzle. The sand, being forced out at high velocity by the air pressure, may be directed at all parts of the pieces to be cleaned. This is one of the most efficient methods of polishing and finishing a gear and does not injure the hard metal surface in any way.

Fig. 2. Gear Case-hardening Room in the Premier Factory

As silence of operation of all moving parts is one of the principal requisites for a motor car of to-day, it is necessary that the teeth of all gears shall be made to mesh perfectly and smoothly with all of those on the other gears with which they come in contact. In order to obtain silence of operation, the gears are run with each other for some time and each tooth is worn to a more perfect fit. The first few weeks of

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operation by the customer would wear the gears in properly, but, in order to produce a perfect car, this is done before it leaves the factory. Most of this "running in" of the gears can be accomplished by the thorough road test to which the whole car is subjected before leaving the shop, but many of the leading factories supplement this with additional methods for bestowing the required wear on the transmission. A special frame is used in the Marmon factory, in Indianapolis (see Fig. 3), in which the transmission, driving shaft, differential, and rear axle and wheels are set up. An

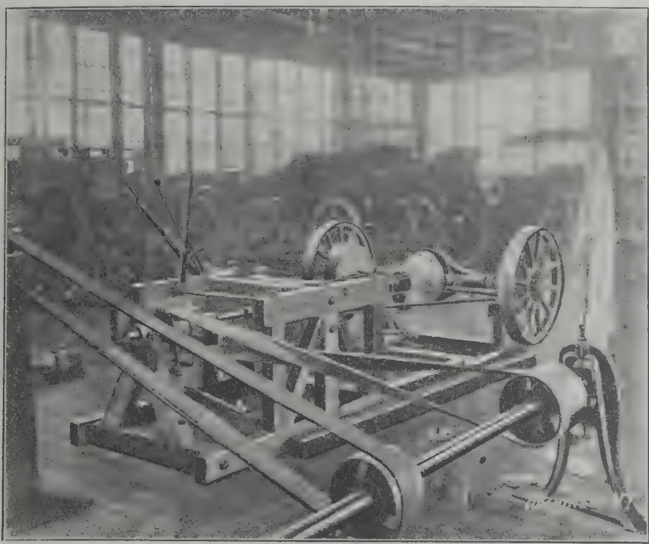

Fig. 3. Running in the Transmission and Differential Gears in the Marmon Factory

idler and a driving pulley, with a belt shifter, are attached to the front end of the transmission shaft and connected by belt to a countershaft driven from the main line shafting. When the power is applied and the different speeds of the transmission are thrown into mesh by the shifting lever, every gear of the whole car, with the exception of those used on the motor, will be set in motion. The gears of the engine are worn in when it is operated under belt power before installation in the chassis. Somewhat the same method is pursued in the Packard factory, in Detroit, the only difference between the two being that here, instead of allowing the wheels to run free, a brake is attached to the end of the driving shaft by means of which a variable load may be applied to the gears in mesh. A section of the testing room is devoted to this purpose, and as the transmission and rear axle are assembled, they are brought in, placed on special

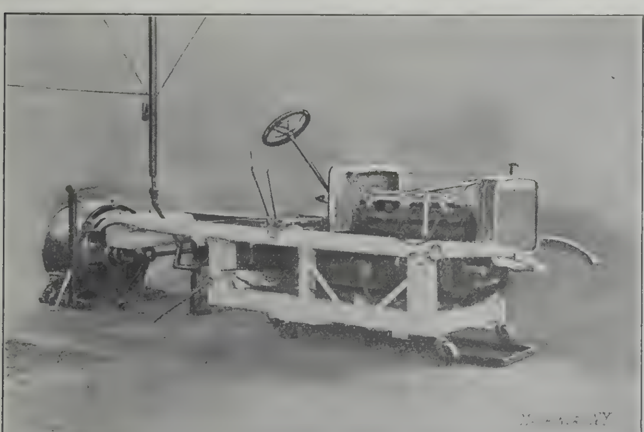

Fig. 4. Preliminary Run of Engine and Transmission to wear in the Parts

frames provided for the purpose and connected by belts to overhead shaftings. As the gears of the transmission and differential are run in, the loads are increased until all are worn perfectly smooth.

Before their final installation in the motor and transmission, all of the spur gears for the Winton cars, made in Cleveland, are set up in a special case and run in under belt power. The bearings in these special cases are set at the proper distances apart to accommodate the various gears of a train, thus wearing in the gears so that all of those for similar parts are absolutely interchangeable. The case is made oil-tight and a mixture of finely powdered emery and lubricating oil is fed through an opening in the top so that this grinding material will come in contact with all the teeth of the gears in mesh in the train. This grinding is continued until each tooth has been worn perfectly smooth and to an accurate fit with the teeth of the other gears with which it comes in mesh. For the gears used in the front of the motor to drive the cam, pump and magneto shafts—gears which always occupy the same relative position in regard to each other—a tooth of each is marked when in the grinding case with the corresponding teeth of the others with which it meshes. This is done so that each gear of the train may be set up in the motor in the same corresponding position as that occupied while being worn to a perfect fit with the others in the case. It is evident that every tooth cannot be of *exactly* the same size and shape, and if each tooth is allowed to mesh with those with which it came in contact while being ground, more perfect rolling contact will take place and less friction and noise will be set up. The marks made on the gears are also useful for timing the magneto and valve cam shafts when the occasion arises necessitating the removal of any of these parts from the motor. Of course, it is impossible to carry this practice to the transmission, for most of the gears on one shaft revolve independently of those on the other, and it is very seldom that the same teeth of two gears will come into mesh on succeeding occasions. This practice, however, may be applied to the bevel gears of the driving shaft and rear axle and the pinions of the differential. As a further means of wearing the gears of the transmission to a perfect fit, the motor, transmission and driving shaft are installed in the chassis as

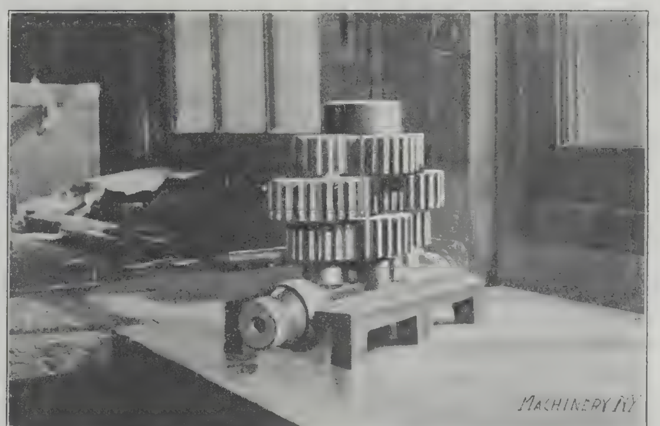

Fig. 5. Device for Testing the Accuracy of Gears

shown in Fig. 4, and the motor is run while the various speeds of the transmission are thrown into mesh in order to wear in every gear thoroughly. During this run an electric dynamometer, by means of which a variable load may be applied, is connected to the end of the driving shaft.

An ingenious device for testing the accuracy of gears is used in the factory of the Grabowsky Power Wagon Co., of Detroit. This consists of a standard having three pins or bearings set in it on which the gears of the transmission are placed as shown in Fig. 5, thus forming a replica of the planetary transmission as used in the car. The middle upright bearing is stationary while each of the other two is movable in a horizontal direction and is connected to a micrometer at either end of the base of the instrument. A master gear is set on one of these bearings, while the pinions to be tested are placed on the other two. When the two movable bearings have been so adjusted that all of the gears mesh perfectly, the readings of the two micrometers may be observed and the amount, in thousandths of an inch, by which the gears are "off" may thus be determined accurately. Certain limits of variation are necessarily allowed, but if any gear is below one or above the other, it is thrown out. Inasmuch as the distance between the centers of the gears must be constant in the transmission case, this instrument is useful in determining just what gears are acceptable without the necessity of installing them in the case.

Many of the gears used in the forward end of the motor for driving the cam, pump and magneto shafts are made of

manganese-bronze. The Premier car, however, made in Indianapolis, employs a laminated gear for the magneto shaft, built up of alternate layers of bronze and fiber. These layers are pinned firmly together and the gear is then cut by the usual methods. This makes an exceedingly quiet-running gear, as the layers of fiber or rawhide cushion the impact of the teeth as they meet, and the whirring or grinding sound familiar in many all-metal gears is practically eliminated. It has been found by means of a series of exhaustive tests conducted in this factory that the silent running of this gear is brought about by a slight rounding or "bulging" of the face of the rawhide sections caused by the absorption of the lubricating oil in the pores of the fiber and the pressure against its sides. This, as mentioned above, effectually cushions the impact of the teeth, but if this bulge becomes too great, the teeth will not mesh properly, there will be a tendency to "jam" and more friction will be set up than would be the case were an all-metal gear used. Of course the wider these fiber sections are, the greater will be the bulge to each, and it has been found as a result of these experiments that laminated gears composed of layers of rawhide about 1/8 of an inch thick, alternating with bronze disks of the same dimensions, give the best service for this purpose. When sections of this thickness are used, a sufficient bulge is formed to cushion the impact satisfactorily, and yet this is not great enough to change the shape of the teeth materially. These experiments are still in progress at the factory in question in order the more accurately to determine other facts and figures concerning the best form of laminated gears, and this is only one of the many instances which give evidence to the fact that the American motor car manufacturer is now fully awake to the importance of paying attention to the most minute detail of design.

* * *

SIMPLIFIED METHODS FOR FLY-WHEEL CALCULATIONS*

R. J. WILLIAMS†‡

In several previous issues of MACHINERY methods and formulas have been given relating to the design of fly-wheels and the size of motor required for giving out a certain amount of energy per stroke of the machine under consideration. In this article a method of calculation will be given whereby the work of finding the desired results may be considerably shortened.

In shears of large size cutting short pieces, where the maximum effort may be required almost continuously it is of great importance that motor and fly-wheel be of sufficient capacity to perform their work properly. Since the amount of energy to be given out by the fly-wheel depends upon the size of the motor, this should always be determined first.

Let

E = total energy required per stroke,
E_1 = energy given up by motor during cut,
E_2 = energy given up by fly-wheel,
T = time in seconds per stroke,
T_1 = time in seconds in which E_1 is given up,
T_2 = time in seconds in which E_2 is restored to fly-wheel,
V_1 = initial velocity of fly-wheel in feet per second,
V_2 = velocity after cut in feet per second,
R_1 = initial revolutions per minute of fly-wheel,
R_2 = revolutions per minute after cut,
R_3 = revolutions per minute after n cuts,
W = weight of fly-wheel rim in pounds,
D = mean diameter of fly-wheel rim in feet,
H_1 = horse-power required to cut every stroke,
H_2 = horse-power actually used,
a = width of fly-wheel rim,
b = depth of fly-wheel rim,
g = 32.16,
n = number of cuts shear will make for a total given reduction in speed.

In the July, 1907, issue of MACHINERY this formula for horse-power was given:

$$\text{H. P.} = H_1 = \frac{EN}{33{,}000},$$

and since $N = \dfrac{60}{T}$ we have

$$H_1 = \frac{E}{550T} \qquad (1)$$

$$H_1 = \frac{E_1}{550T_1}$$

$$E_1 = 550\,T_1\,H_1 = \frac{550\,E\,T_1}{550\,T} = \frac{E\,T_1}{T}$$

$$E_2 = E - \frac{E\,T_1}{T} = E\left(1 - \frac{T_1}{T}\right) \qquad (2)$$

Having now the energy that must be given out by the fly-wheel, we can proceed as follows:

We know that $E_2 = \dfrac{W}{2g}\,(V_1^2 - V_2^2)$ and that

$$V_1^2 = \left(\frac{D \times \pi \times R_1}{60}\right)^2 = 0.00274\,D^2\,R_1^2$$

$$V_2^2 = \left(\frac{D \times \pi \times R_2}{60}\right)^2 = 0.00274\,D^2\,R_2^2$$

$$V_1^2 - V_2^2 = 0.00274\,D^2\,(R_1^2 - R_2^2)$$

$$E_2 = \frac{W}{64.32} \times 0.00274\,D^2\,(R_1^2 - R_2^2)$$

$$E_2 = 0.0000426\,W\,D^2\,(R_1^2 - R_2^2) \qquad (3)$$

$$W = \frac{E_2}{0.0000426\,D^2\,(R_1^2 - R_2^2)} \qquad (4)$$

Making $0.0000426\,(R_1^2 - R_2^2) = CR_1^2$ we have

$$E_2 = CWD^2R_1^2 \qquad (5)$$

$$W = \frac{E_2}{CD^2R_1^2} \qquad (6)$$

In cast-iron fly-wheels it is usual not to exceed a speed which represents a fiber stress of more than 1,000 pounds per square inch of rim cross-section. The stress in pounds due to centrifugal force equals $0.0972\,V_1^2$ for cast iron, and for fly-wheels having a maximum stress of 1,000 pounds per square inch we can develop the following formulas:

$0.0972\,V_1^2 = 1{,}000;\ V_1 = 101.5.$

But $V_1 = \dfrac{D\pi R_1}{60}$, therefore we have

$$101.5 = \frac{D\pi R_1}{60}$$

$$R_1 = \frac{101.5 \times 60}{D\pi} = \frac{1940}{D} \qquad (7)$$

$$D = \frac{1940}{R_1} \qquad (8)$$

Squaring (7) we have $R_1^2 = \dfrac{1940^2}{D^2}$

Substituting this in (6) we have

$$W = \frac{E_2}{C\,D^2\,\dfrac{1940^2}{D^2}} = \frac{E_2}{1940^2\,C}$$

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: A Safe Form of Fly-wheel, July, 1899; Fly-wheel Designing, October, 1899; Safe Speed for Fly-wheels, November, 1902, engineering edition; Fly-wheel Explosions and their Cause, January, 1903, engineering edition; Fly-wheels, June, 1903, engineering edition; Gyroscopic Effect of Fly-wheels on Board Ship, May, 1904, engineering edition; The Bursting of Four-foot Fly-wheels, January, 1905, engineering edition; Sixty-ton Fly-wheel, July 1906, engineering edition; Size, Weight, and Capacity of Fly-wheels for Punches, July, 1907, engineering edition; Formulas for Gas Engine Fly Wheels, August, 1907, engineering edition; Fly-wheels for Planers, November, 1907; On Determining size of Fly-wheels for Motor-driven Planers, December, 1907. See also MACHINERY'S Reference Series No. 40, Fly-wheels.

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‡ Roy J. Williams was born in Syracuse, Ohio, 1884. He received a high school education and became a mechanical draftsman through home study. He has worked as draftsman with the Labelle Iron Works, Steubenville, Ohio; Mutual Electric & Machine Co., Wheeling, W. Va., and the Wheeling Mold & Foundry Co., Wheeling, W. Va. His specialty is rolling mill design.

Making $1940^2 C = C_1$, and $\dfrac{1}{C_1} = C_2$ we have

$$W = \frac{E_2}{C_1} = C_2 E_2 \qquad (9)$$

The following are the values of C, C_1, and C_2 for different reductions in speed:

Per Cent Reduction	C	C_1	C_2
2½	0.00000213	8.00	0.1250
5	0.00000426	16.00	0.0625
7½	0.00000617	23.20	0.0432
10	0.00000810	30.45	0.0328
12½	0.00001000	37.60	0.0266
15	0.00001180	44.50	0.0225
20	0.00001535	57.70	0.0173

Size of Rim

Let us assume that the depth of rim equals 1.22 times the width. We have then these formulas for size of rim:

$$a = \sqrt{\frac{W}{12D}} \qquad (10)$$

$$b = 1.22\,a \qquad (11)$$

These two formulas can be changed to suit any required ratio of depth to width of rim.

Let y = required ratio,

$$a = \sqrt{\frac{1.22W}{12Dy}} \qquad (12)$$

$$b = ya \qquad (13)$$

Effect of Changing Size of Motor

Let us now suppose that we do not wish to use a motor large enough to cut continuously, and desire to find how many cuts the machine would make continuously without drifting down more than a certain percentage of the original speed. Transposing (3) we have

$$R_1^2 - R_2^2 = \frac{E_2}{0.0000426\,WD^2}$$

$$\text{Let } \frac{E_2}{0.0000426\,WD^2} = K.$$

$K = R_1^2 - R_2^2$, and

$R_2 = \sqrt{R_1^2 - K}$

$$R_3 = \sqrt{R_1^2 - nK + (n-1)K\frac{H_2}{H_1}} \qquad (14)$$

After several reductions we have

$$n = \frac{\dfrac{H_1(R_1^2 - R_3^2)}{K} - H_2}{H_1 - H_2}$$

and since $K = R_1^2 - R_2^2$ we have

$$n = \frac{\dfrac{H_1(R_1^2 - R_3^2)}{R_1^2 - R_2^2} - H_2}{H_1 - H_2} \qquad (15)$$

The time now required to bring the fly-wheel up to full speed again after n cuts will be

$$T_2 = \frac{E_2}{550\,H_2} \qquad (16)$$

Examples

We will now work out some examples illustrating the use of these formulas.

Example 1.—A hot slab shear is required to cut a slab 4×15 inches which, at a shearing stress of 6,000 pounds per square inch, gives a pressure between the knives of 360,000 pounds. The total energy required for the cut will then be $360{,}000 \times \dfrac{4}{12} = 120{,}000$ foot-pounds. The shear is to make 20 strokes per minute, and with a six-inch stroke the actual cutting time is 0.75 second and the balance of the stroke is 2.25 seconds.

The fly-wheel is to have a mean diameter of 6 feet 6 inches and is to run at a speed of 200 R. P. M.; the reduction in speed to be 10 per cent per stroke when cutting.

$$H_1 = \frac{120{,}000}{3 \times 550} = 72.7 \text{ horse-power.}$$

$$E_2 = 120{,}000 \times \left(1 - \frac{0.75}{3}\right) = 90{,}000 \text{ foot-pounds.}$$

$$W = \frac{90{,}000}{0.0000081 \times 6.5^2 \times 200^2} = 6570 \text{ pounds.}$$

Assuming a ratio of 1.22 between depth and width of rim,

$$a = \sqrt{\frac{6{,}570}{12 \times 6.5}} = 9.18 \text{ inches,}$$

$b = 1.22 \times 9.18 = 11.2$ inches,

or size of rim, say, $9 \times 11\frac{1}{2}$ inches.

Example 2.—Suppose we wish to make the fly-wheel in Example 1 with a stress of 1,000 pounds, due to centrifugal force per square inch of rim section.

C_2 for 10 per cent $= 0.0328$,

$W = 0.0328 \times 90{,}000 = 2{,}950$ pounds,

$R_1 = \dfrac{1{,}940}{D}$. If $D = 6$ feet, $R_1 = \dfrac{1{,}940}{6} = 323$ R. P. M.

$$a = \sqrt{\frac{2{,}950}{12 \times 6}} = 6.4 \text{ inches,}$$

$b = 1.22 \times 6.4 = 7.8$ inches.

or size of rim, say, $6\frac{1}{4} \times 8$ inches.

Example 3.—Let us now suppose that in Example 1 we wish to use a 50 H. P. motor, and wish to find how many cuts the shear will make continuously without drifting down more than 20 per cent in speed? And what time must be allowed for the motor to restore the fly-wheel to its original speed?

$R_1^2 - R_3^2 = 200^2 - 160^2 = 14400$

$R_1^2 - R_2^2 = 200^2 - 180^2 = 7600$

$$n = \frac{\dfrac{72.7 \times 14400}{7600} - 50}{72.7 - 50} = 3.86 \text{ cuts}$$

Allowing the shear to make 4 cuts we have

$$R_3 = \sqrt{200^2 - 4 \times 7600 + 3 \times 7600 \times \frac{50}{72.7}} = 159 \text{ R. P. M}$$

$E_2 = 0\,0000426 \times 6570 \times 6.5^2 \times (200^2 - 159^2) = 175{,}000$ foot-pounds, about.

$$T_2 = \frac{175000}{550 \times 50} = 6.4 \text{ seconds.}$$

Example 4.—Let us now suppose that in Example 2 we wish to use a 50 H. P. motor under the same conditions as in Example 3.

$R_1^2 - R_3^2 = 323^2 - 258^2 = 37750$

$R_1^2 - R_2^2 = 323^2 - 291^2 = 19650$

$$n = \frac{\dfrac{72.7 \times 37750}{19650} - 50}{72.7 - 50} = 4 \text{ cuts, nearly.}$$

$E_2 = 0.0000426 \times 2950 \times 6^2 \times (323^2 - 258^2) = 170{,}000$ foot-pounds, about.

$$T_2 = \frac{170{,}000}{550 \times 50} = 6.2 \text{ seconds.}$$

These examples show the possibilities of the formulas as time-savers for the designer, by reducing the calculations to the smallest possible number, and at the same time reducing the possibility of error.

* * *

Vice-Consul-General Richard Westacott reports that on July 1 there were 3,394 public motor cabs in use in London, this being an increase of 1,886 over the number one year ago. In other words, the number of motor taxicabs has more than doubled in a year, while the number of licensed horse-drawn hansom cabs decreased 1,290 in one year, and the number of four-wheeled horse-drawn cabs decreased by 389. The total number of all kinds of public cabs in London is nearly 11,000.

GLENN H. CURTISS

THE MAN, THE AEROPLANE AND THE MOTOR

Glenn H. Curtiss

Glenn Hammond Curtiss was born May 21, 1878, at Hammondsport, N. Y. Here he received his early education and planned for the future, although he hardly could have dreamed of what he has actually been able to accomplish, namely to go faster on the ground than any other person, and to fly through the air and win in competition over the best aviators of the world.

Mr. Curtiss attended school in Rochester, N. Y., and started in the bicycle business in Hammondsport in 1900. It was at this time that he built one of the first motor cycles ever constructed in this country, and he says that he never since has had such pleasure from any of his successes as came to him when, for the first time, the motor made a few explosions and ran for half a block.

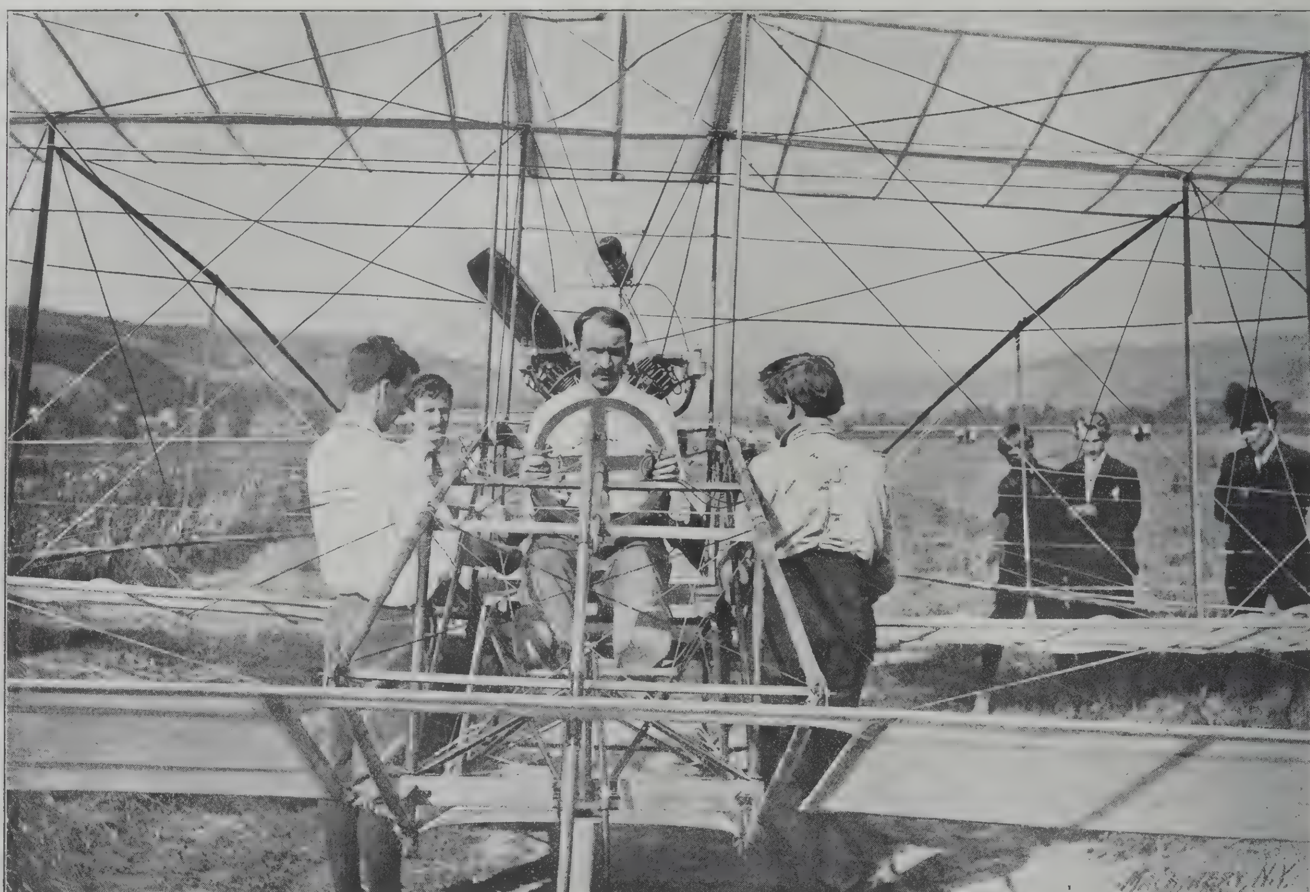


Fig. 1. Glenn H. Curtiss in the "June Bug," Ready for Flight

On January 23, 1907, at Ormond Beach, Fla., Mr. Curtiss made a record for the distance of one mile in the extraordinary time of 26 2/5 seconds with a 40-horse-power air-cooled motor cycle which he had built entirely in his own factory. This is the fastest speed ever made with any form of vehicle, and means a speed of about one hundred and thirty-seven miles an hour.

Mr. Curtiss' first interest in aeronautics came from Captain Thomas S. Baldwin who, in seeking a good motor to drive his airships, found the Curtiss the best and most reliable for the purpose. Mr. Curtiss built the first water-cooled motor to be used in the dirigible balloon which Captain Baldwin built for the United States Signal Corps and which made 19.61 miles an hour in its official speed test and flew in its official endurance trial for two hours. Mr. Curtiss operated the engine while Captain Baldwin steered the airship during its flights which were held at Fort Myer, Va., near Washington. These flights, and one made a short time previously, were the first opportunities that Mr. Curtiss had to navigate the air.

In the latter part of 1907 the Aerial Experiment association was formed by Dr. Alexander Graham Bell, the inventor of the telephone, who is greatly interested in the subject of aeronautics, and Mr. Curtiss was appointed the director of experiments. The other members of the association were Mr. F. W. Baldwin, M.E., Toronto University, chief engineer, who made the first public flight in America in a heavier-than-air flying machine, March 12, 1908, in the first machine built by this association, Selfridge's *Red Wing*, which flew over the ice on Lake Keuka, near Hammondsport, N. Y. The treasurer of this association was Mr. J. A. Douglas McCurdy, M. E., Toronto University, who was also assistant engineer and secretary since the death of Lieut. Selfridge. Mr. McCurdy made over three hundred successful flights, averaging nearly nine miles each and covering in the neighborhood of three thousand miles. These flights were made over the ice in Baddeck Bay, Nova Scotia, in his machine the *Silver Dart*, built by the association. The other member of this association was Lieut. Thomas E. Selfridge, military expert in aeronautics detailed by the United States government to observe the experiments of the association, in the interest of the United States Army and acting as secretary of the association. Lieut. Selfridge was killed September 17, 1908, in the accident to Orville Wright's flying machine at Fort Myer, Va., near Washington, D. C. This is the first and only serious accident recorded in the recent* work of aviation, and of many thousands of flights in public in heavier-than-air machines there are only six recorded fatal accidents.

The third machine built by the association was the *June Bug* and on July 4, 1908, with it Mr. Curtiss contested for and won the *Scientific American* trophy, offered to the first machine heavier than air to fly one kilometer in a straight line. In this contest he made a record of 1¼ mile in 1 minute 42 2/5 seconds.

Three more machines were built, including the machine which one year later made a second record for the *Scientific American* trophy, July 17, 1909, flying 24.7 miles in 52 minutes

* See article, "Aeroplane-Type Flying Machines," December, 1908.

* Since this article was written S. Lefebvre was killed at Juvisy-sur-Orge, France, September 7.

30 seconds, and the machine in which, representing the Aero Club of America, Curtiss won the Gordon Bennett International Aviation Cup at Rheims, August 28, 1909, flying 20 kilometers (12.42 miles) in 15 minutes 50 3/5 seconds, a speed of 47 miles an hour, bringing this famous cup and contest to America where the race for it will be held next year. Mr. Curtiss also won, during the "Aviation Week at Rheims," the Prix de la Vitesse by flying over a course of 30 kilometers in length, in 23 minutes 29 seconds, surpassing the best records of the foremost aviators in the world.

A description of the machine with which Mr. Curtiss accomplished these wonderful results will be interesting:

The Herring-Curtiss No. 1, as it is now called, is a biplane with front control, rear control, side control or wing tips, starting and landing wheels, and motor. The main surfaces are 28 feet 9 inches by 4 feet 6 inches, one superimposed upon the other and separated by vertical struts, 4 feet 6 inches being the distance between the two planes. These planes are

Fig. 2. The "Gold Bug" in Flight

covered with Baldwin rubber-silk material and the total area is about 258 square feet. There are twenty-two ribs used in the surfaces made of spruce and ash laminated and formed to a curve; they are spaced 15 inches apart and the covering material is laid over them and fastened by a strip of featherbone, laid on the upper side of the material and tacked to the ribs. The angle of these surfaces to the direction of motion is between 4 and 5 degrees when flying. The front control consists of two surfaces each 6 feet wide and 2 feet deep and 2 feet apart and placed about 12 feet in front of the main planes. This whole structure, like a box-kite, is pivoted ten inches back from its front edge upon the frame-work which extends in front of the machine; a rod is connected to the upper part of this control and extends to the steering wheel which can be moved forward or back, thus turning the

Fig. 3. Glenn H. Curtiss on a Motor-driven Ice Boat, on Lake Keuka, near Hammondsport, N. Y.

front control or rudder on its axis making the surfaces point up or down. This tends to raise or lower the front of the machine as, according to its positive or negative inclination, the wind blows against the upper or under side of this front rudder. The rear control consists of a horizontal surface or tail 2 feet 3 inches by 6 feet at the extremity of the framework, about 12 feet in the rear of the main planes, about the same distance to the rear that the front control is ahead of the

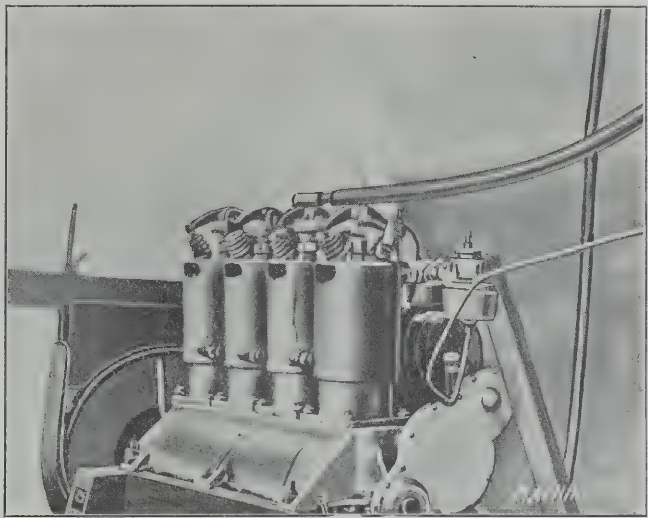


Fig. 4. A Four-cylinder Aeroplane Motor under Brake Test

machine. There is also a vertical rudder 2 feet by 3 feet 4 inches, pivoted 8 inches back from its front edge which is connected by wires to the steering wheel which turns and steers the aeroplane in the horizontal plane in the same manner that a rudder steers a boat in the water.

The side control or wing tips which govern the balancing are perhaps the simplest form of apparatus for accomplish-

Fig. 5. G. von Rattweiler, Designer of the first Three Curtiss Motors, holding a Four-cylinder Motor and Propeller in his Hands

ing this most essential feature and one that has baffled inventors of flying machines more than any other one point. These small surfaces are placed between the main planes at their outer extremity and are 6 feet wide and 2 feet deep. They are hinged at their front edge and both are connected to a pivoted lever in the center of the machine which has a yoke or fork extending on each side of the operator's shoulders in such a manner that when he leans to one side or the other this movement will cause the side planes to act in unison, one, however, pointing down as the other points up. If the machine tips so that the right-hand side is lower than the other, the operator naturally leans to the left or highest side. This movement causes his shoulder to press against

the lever, thereby moving it to the left, and by means of the wires which extend to the planes the right-hand plane is turned to a lifting angle and the left-hand plane to the contrary or a depressing angle in such a manner that the wind will blow against the under side of the right-hand plane and against the upper side of the left-hand plane, thus forming a "couple" tending to right the machine.

The materials of which the machine is constructed consist of Oregon spruce, which is used in the main frame-work, and bamboo which is used in the frame-work supporting the forward and rear controls; steel wire is used for the main bracing and a fine strand wire cable for other bracing and to operate the rudders and controlling planes. The structure for mounting the three 20-inch pneumatic tire wire wheels upon which the machine runs when starting and alighting is made of steel tubing and wood. These wheels are provided with extra wide hubs in order to enable them to withstand any severe lateral strain in landing, and a long skid or reach bar of wood extends from the center of the axle of the two rear wheels, which are directly under the lower main supporting plane, to the single front wheel from which wooden braces extend directly to the engine bed and the upper plane to take up the shock of landing.

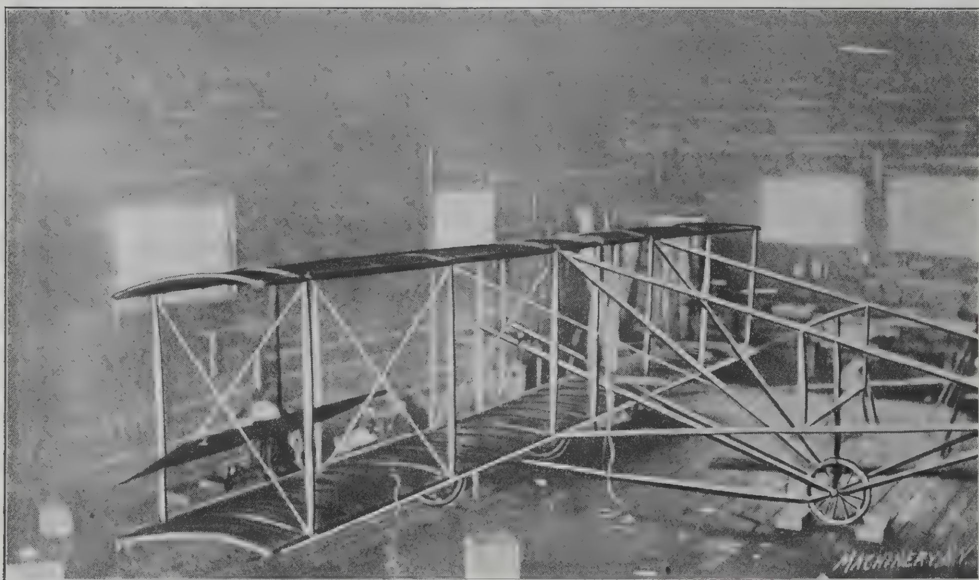


Fig. 6. The "Gold Bug" in Curtiss' Shop at Hammondsport, N. Y.

The operator's seat is just in front of the motor and in the center of the main planes, slightly toward the front of the central panel. The steering wheel is directly in front of him, which he pushes away from him to go down and pulls back to go up, and turns to the right or left to steer in the horizontal plane. At his right foot which rests on a cross-bar is a pedal operating a brake on the front wheel used to bring the machine more quickly to a standstill after landing, and at the same time operating a switch to cut off the motor. The left foot has a small pedal operating the throttle and governing the speed of the engine.

The Curtiss motor is perhaps as important, if not more important, than any other part of the aeroplane. Very few flying machine builders build their own motors, and many were delayed or kept from success by the lack of a good motor. The Wright brothers built a flying machine and then built their motor, while Mr. Curtiss had developed his motor to a state approaching perfection and then built his flying machine.

The motor ordinarily used is a four-cylinder, four-stroke cycle engine, water-cooled by geared pump, with gray iron cylinders 3⅞ by 4⅛ with steel water jackets, giving 28 horsepower at 1,450 revolutions per minute on a water-cooled brake test of six hours continuous running. The compression is high, being about 92 pounds. The lubrication is by high pressure oil system, the pump being built in the crank-case and operated from the cam-shaft, the oil being forced through the cam-shaft which is made of one piece with a 5/16 hole. The oil passes to the main bearings which are plain and to the hollow crank-shaft, 1⅞ inch diameter, which is made of Krupp chrome nickel steel. The oil returns to a reservoir underneath the engine and is pumped over again through the system. The ignition is by Simms-Bosch high-tension magneto. "Mercedes" spark plugs are used, and a Curtiss carbureter. The valves, both in the head of the cylinder, are mechanically operated, very ingeniously, by a rocker arm and a single push rod and cam. The crank-case is of aluminum alloy, also the pistons and connecting-rods. The weight of the engine complete with propeller, carbureter and magneto is about 92 pounds. The propeller is made of wood 5 feet 4 inches in diameter with a five-foot pitch and gives a thrust of 225 pounds pulling against a scale.

The total weight of the machine with operator is about 550 pounds and the complete power plant, including radiator, water and oil, weighs about 195 pounds.

The machine used in Rheims were fitted with an eight-cylinder motor, with cylinders 4 by 4.5 inches placed together like the letter V. It is practically two of the four-cylinder motors put together, weighs, complete, about 200 pounds, and develops about 60 H.P. A large thirteen-gallon and a small three-gallon fuel tank were fitted for the long races and the speed tests respectively. Fifteen inches of surface were taken off each main plane, and the side controls were arched and placed a little further out at the extremities. The propeller gave a thrust of 280 pounds, and the total weight of the whole machine loaded was about 700 pounds. Mr. Curtiss also made some changes in his propeller at Rheims to get the highest efficiency out of his machine, for the relation of speed of the machine, speed of the motor, and size and pitch of the propeller is very important. A. P.

* * *

Many hospitals in England, says the *Scientific American*, are provided with a special apparatus for extracting iron and steel chips from the eye by means of powerful electro magnets. The magnet employed has a core three feet long and six inches in diameter of the best Swedish soft iron. Two hundred pounds of insulated wire are wound in two coils about the core. The end of the magnet is threaded to receive terminals of different shapes to suit various conditions. The magnet is mounted on ball bearings, and can be moved in any direction. The strength of the magnetic field may be varied at will by means of a rheostat. When used at its maximum power, the magnet exerts a pull of 30 pounds per square inch at a distance of an inch. A special type of apparatus is provided for reclining patients; in this case the magnet is mounted on trunnions, and is tilted by means of suitable gearing operated by a hand crank.

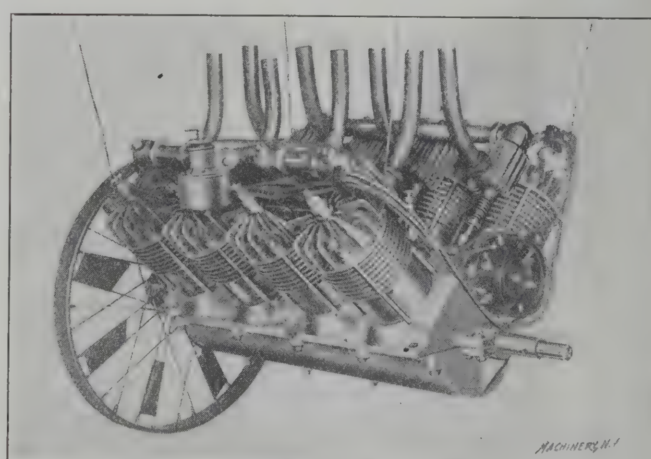


Fig. 7. Forty Horse-power Eight-cylinder, Air-cooled, Curtiss Motor, weighing 145 pounds

BEGINNING OF STEAM NAVIGATION*

Robert Fulton

The one-hundredth anniversary of the successful application of steam to the propulsion of ships by Robert Fulton, and the three-hundredth anniversary of the exploration by Henry Hudson of the river that bears his name, is now being commemorated by a great celebration given by the state of New York. This dual celebration, which is under the auspices of the Hudson-Fulton Commission, began on September 25 and will continue until October 9. It will doubtless surpass, in magnitude and grandeur, anything which has been held on this side of the Atlantic, as every detail which would contribute to its success has been carefully planned and a vast sum of money, roughly estimated at one million dollars, has been expended. As far as possible, exact replicas of Hudson's vessel, the *Half Moon*, and Fulton's historic *Clermont* with which he demonstrated the practicability of the steamboat, have been built. These quaint craft will, in connection with a great naval parade, be convoyed on October 1st by a fleet of American and foreign men-of-war, up the Hudson.

Fig. 1. The Replica of the Clermont

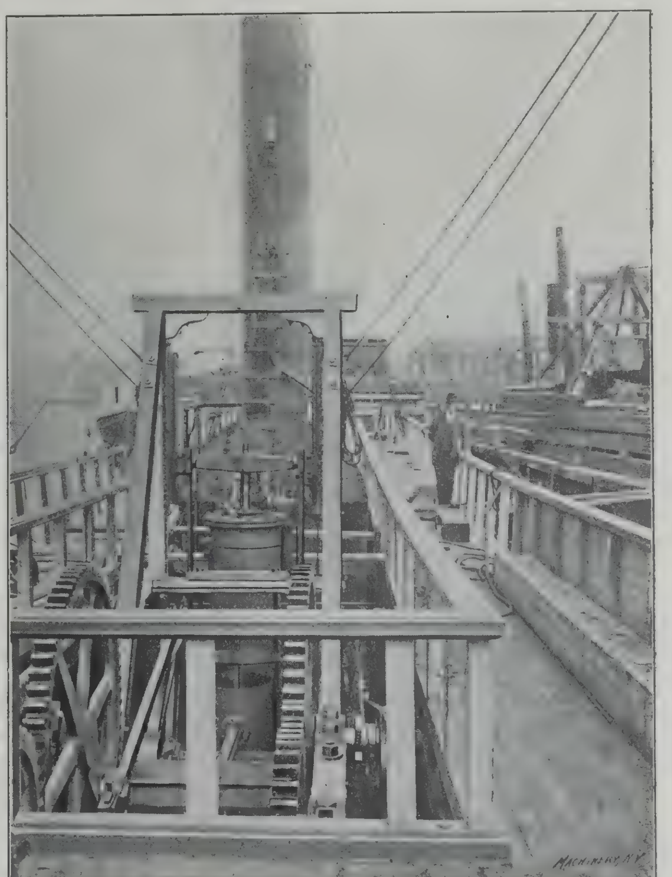


Fig. 2. View of the Engine after Installation

As is well known, Robert Fulton was not the first man to build a steamboat, a number of other boats using steam having preceded the *Clermont;* but if we may judge from descriptions and models of some of these, their priority detracts but little from Fulton's achievement, as he constructed the first boat that was a commercial success. Nevertheless, much that Fulton accomplished was undoubtedly due to the ideas he obtained from those whose experiments antedated the construction of the *Clermont.* James Rumsey began experimenting as early as 1785, and a year later John Fitch is said to have constructed the first steam-propelled craft which met with any degree of success in America. It was a most clumsy contrivance, however, being propelled by gangs of oars arranged in a frame-work at the sides. The second American steamboat was run by Fitch on the Delaware at Philadelphia in 1787. In the same year Rumsey is said to have built the third boat which operated on the Potomac. The propulsion of this novel craft was accomplished by sucking in water at the bow and expelling it at the stern—a method which has been tried in recent times, but without success. In the two following years Fitch built two other steamboats, after which Samuel Morey built a stern-wheeler, which made a trip from Hartford to New York. Fitch, who had been conducting his experiments on the Delaware at Philadelphia, came to New York where he operated the seventh American steamboat on the old Collect Pond, a small body of water which then existed where the City Prison and Criminal Courts Building now stand. This boat was propelled both by paddle wheels at the side and a screw propeller. The construction of the mechanism was exceedingly crude and primitive, the boiler being made from a ten-gallon iron kettle, which was closed by a heavy plank lid. The factor of safety was probably a most uncertain quantity.

John Stevens began his work in steam navigation in 1791. In 1798, a steam-propelled vessel was tried on the Passaic River. The New York Legislature was petitioned by Stevens for a monopoly of steam navigation, but the petition was not granted. In 1804 a 68-foot boat, 14 feet wide, fitted with a single-screw propeller, was built by Stevens and in 1805 a twin-screw boat was launched on the North River. The machinery of this boat was afterward placed in a larger boat, the *Phoenix*, which was 103 feet 3 inches long, 16 feet wide, and 6 feet 9 inches deep. While the launching of the *Phoenix* occurred after that of the *Clermont,* if one may judge from models, the lines of Steven's craft were much superior to those of the *Clermont.* The engine also shows greater simplicity. In the spring of 1809, the *Phoenix* made a number of trips between New York and New Brunswick, a distance of 37 miles, in 9½ hours including stops, but perhaps owing to the fact that the nearly completed *Rariton* (Fulton's second boat) was intended for operation over this course, it was decided to sail the *Phoenix* to the Delaware River by way of the Atlantic. She left New York on June 8, 1809, arriving at Philadelphia on June 17. Thus was accomplished the first sea voyage of a steam-propelled vessel. The *Phoenix* ran as a passenger boat on the Delaware, stopping at Philadelphia,

* For additional information on this subject, see the article on "Early Steam Navigation," published in the May, 1902, number of MACHINERY.

Bordentown, and Trenton where connection was made with stages across New Jersey to New Brunswick, one of the terminals of the *Rariton*. After running for a number of years over this route the *Phoenix* was wrecked at Trenton in 1814.

The original *Clermont* was built at Charles Brown's shipyard near Corlear's Hook, New York. According to a letter written by Fulton to James Watt, she was 175 feet long, had a beam of 12 feet, and a depth of 8 feet. After making four trips the length was reduced to 150 feet and the width increased to 18 feet. The hull was flat bottom, and wedge shaped at both the bow and stern. The sides were nearly vertical, the width across the main deck being only a little more than at the bottom. As there was no keel, two steering-boards or leeboards were provided to prevent drifting sideways. The propulsion was by paddle wheels, 15 feet in diameter, which were placed well forward. These were driven by a single-cylinder condensing engine of the side-lever type, which was imported from England, as the facilities in this country at that time for engine building or similar work were very poor. This engine with its driving mechanism was located amidships, and was uncovered. An idea of its construction may be obtained by referring to Fig. 3 which shows an elevation and plan of the engine built for the new *Clermont*. Fig. 2 shows the appearance of the engine after installation. The cylinder, which was designed for a working pressure of 20 pounds, is mounted vertically on a cylindrical condenser, which is connected to the air pump by a channel-way of cast iron, which forms the bed-plate of the engine. The valves, which are of the single poppet type, are located in cylindrical steam chests arranged at each end of the cylinder. The valve gear of the first *Clermont* required four men to start the engine. It was afterwards changed to the Stevens type, the fundamental principles of which are seen in the engines of the modern river boats. The diameter of the cylinder is 24 inches, and the length of stroke 4 feet. The fly-wheels are located outside of the hull, and are driven from the paddle-shafts on either side by two-to-one gearing. This gearing is of cast iron, and machine molded. The fly-wheels are also cast iron and have a rim section of 4 x 4 inches. It is said that upon one occasion when one of the paddle-wheels was disabled, paddles were attached to the fly-wheel and the voyage continued. The side-levers, which are connected with the cross-head and paddle-shaft cranks, are counterweighted as shown, to balance the weight of the piston-rod, crank, air-pump gear, etc. The air pump is single-acting and is connected with the side-levers by links. From the cross-head of the air pump the feed and bilge pumps are driven.

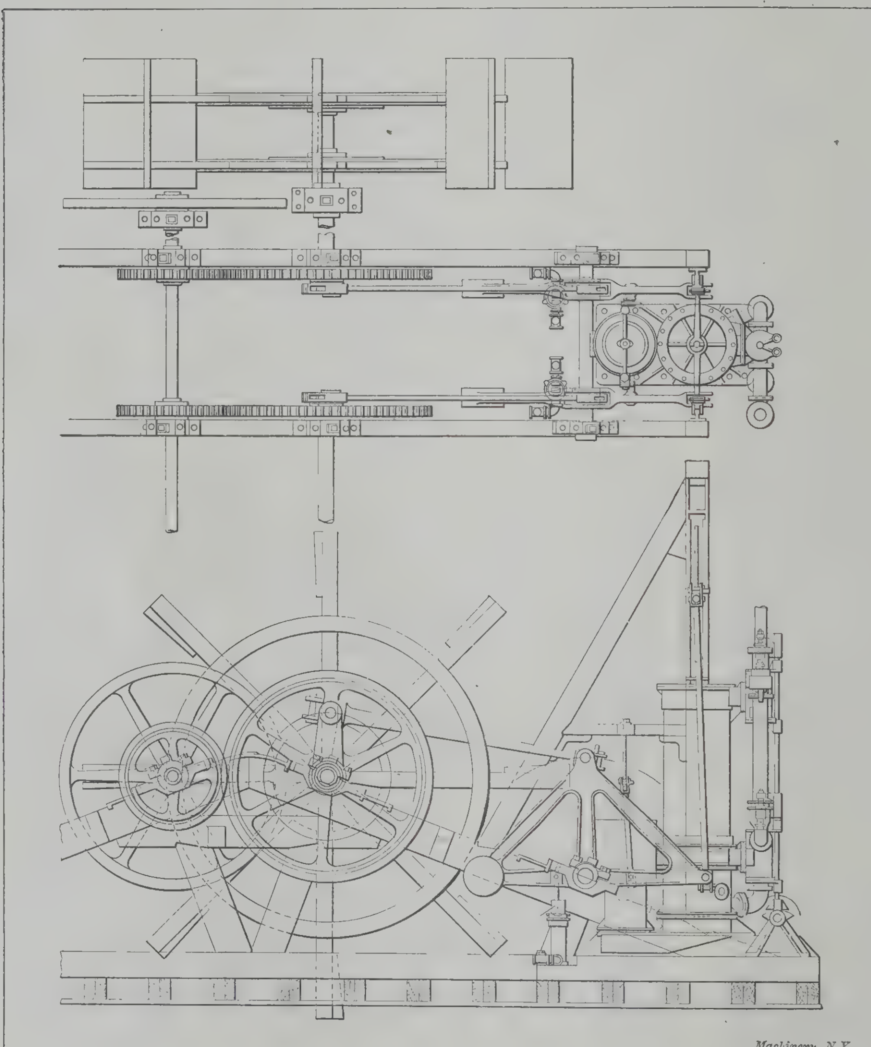


Fig. 3. Plan and Elevation of the Engine which was built for the new Clermont

The boiler of the original *Clermont* was of copper, but no attempt at an exact reproduction of this part has been made, as such a boiler would not pass the United States inspection laws. With this single exception, however, the new *Clermont* is said to be an accurate reproduction of the original. The problem of constructing such a boat was exceedingly difficult, for while drawings of the engine were in existence there was no contemporary picture of the hull. After a careful and painstaking investigation on the part of her architects, the firm of J. W. Millard & Bro. in conjunction with Mr. Frank E. Kirby, consulting engineer, sufficient data were obtained to accomplish the desired result.

The famous voyage of the original *Clermont* from New York to Albany began on August 17, 1807. The start was made from a point near the square, which is now bounded by Washington, West Tenth, West and Charles Streets. Leaving New York at one o'clock in the afternoon, the *Clermont* arrived at the estate of Chancellor Livingston, at 10 o'clock on Tuesday, having traveled 110 miles in 24 hours at an average speed of 4.6 miles per hour. On the remaining 40 miles of the journey to Albany, this speed was increased to 5 miles per hour, making 32 hours the total time for the trip. The next day the return journey began, and just 30 hours afterward the maiden voyage was ended.

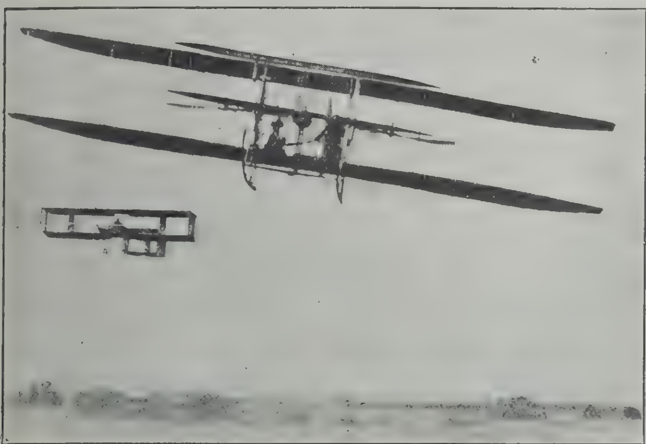
On returning from the first trip, the *Clermont* underwent some improvements to better fit her for regular passenger traffic. At the end of this time the following rates to various points from New York were advertised: Newburgh, $3, time 14 hours; Poughkeepsie, $4, time 17 hours; Esopus, $4.50, time 20 hours; Hudson, $5, time 30 hours; Albany, $7, times 36 hours. Under favorable conditions trips were made to Albany in 28 hours, at a rate of 6 miles an hour. At times as many as 100 passengers were carried. These trips were continued until late in the fall of 1807, and the service was resumed in the spring of 1808. In writing to Livingston of the financial return from passenger traffic, Fulton says: "By carrying for the usual price there can be no doubt but the steamboat will have the preference because of the certainty and agreeable movement. I have seen the captain of a fine sloop on the Hudson. He says the average of his passages has been 48 hours. For the steamboat it would have been 30 hours certain. The persons who came down with me were so pleased that they said were she established to run periodically they would never go in anything else."

The construction of the *Clermont* did not mark the beginning nor the end of Fulton's achievements, for both prior and subsequent to the advent of this famous craft, his genius expressed itself in valuable pioneer work with submarine boats, torpedoes, inland canals, and in other directions in the realm of mechanics and marine construction; and, through the efforts of this early inventor, much was accomplished toward laying the foundation of our present nautical development.

AVIATION RECORDS AT RHEIMS

A. P.

The international meet of flying machines or "Aviation Week," at Rheims, France, in the latter part of August, was the most notable event in the history of aviation. America was ably represented by Mr. Glenn H. Curtiss, who won the Gordon-Bennett International Aviation Cup, on August 28. He represented the Aero Club of America, with a machine of his own make, and defeated one representative of England using a French machine, and three representatives of the Aero Club of France. Mr. Curtiss flew 20 kilometers (12.42 miles) in 15 minutes 53 3/5 seconds, his speed being about 47 miles an hour. His nearest rival was M. Louis Bleriot who made

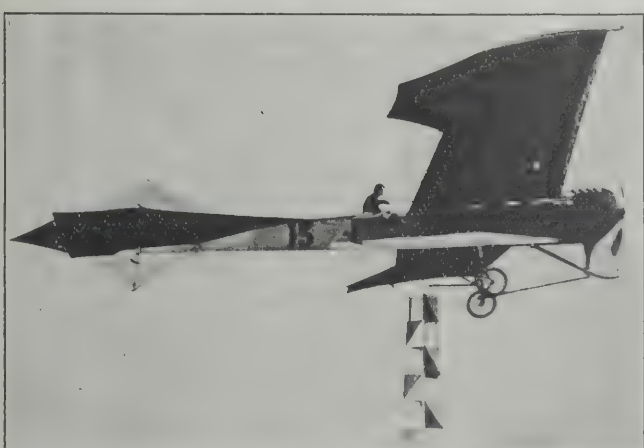


Paul Thompson, N. Y.

Fig. 1. The Wright Machine at Rheims followed by Paulhan. Two Machines caught by the Photographer in the Same View

the course in 15 minutes, 56 1/5 seconds, while Mr. Latham got third place, his time being 17 minutes, 32 seconds. M. Lefebvre made fourth place, his time being 20 minutes, 47 seconds. Each contestant was allowed only one trial. The prize was a trophy valued at 12,500 francs ($2,500), which goes to the club of which the contestant was a representative, and a cash prize of 25,000 francs ($5,000) to the winner.

The Gordon-Bennett contest was the culmination of the most intensely interesting sporting event ever held in the history of the world, and was epoch-making in the annals of mechanical flight. The contest revealed a new field of sport and pleasure heretofore absolutely unknown except to scientists and inventors.



Paul Thompson, N. Y.

Fig. 2. Bleriot rounding Turn at Rheims. View taken from Paulhan's Machine

Curtiss also won the Prix de la Vitesse of 20,000 francs ($4,000), making 30 kilometers (18.63 miles) in 25 minutes, 29 3/5 seconds with the penalization of one-tenth. Bleriot won the prize for the fastest time for one round of the course, 10 kilometers (6.21 miles) in 7 minutes, 47 seconds. Henry Farman won the Grand Prix de Champagne, 50,000 francs ($10,000) by a world's record flight of 180 kilometers (111.98 miles) in 3 hours, 4 minutes, 56 seconds. He flew after the official hour for the timers to leave, 7:30 o'clock, until he had covered 190 kilometers, the time being 3 hours, 15 minutes. The excess distance, however, is not a part of the official record. Mr. Farman also won the passenger carrying contest, carrying two passengers 10 kilometers (6.21 miles) in 9 minutes, 52 seconds. Herbert Latham won the Prix de l'altitude, 10,000 francs ($2,000), reaching a height of 155 meters, or over 500 feet.

There were six principal types of machines used, the Wright and the Curtiss biplanes (American), and the French biplanes of Farman and Voisin, and the monoplanes of Latham (Antoinette) and Bleriot. It is estimated there were altogether 1,300 flights made during the aviation week. The following is a tabulated record of the principal events, competitors, and time:

GRAND PRIX DE CHAMPAGNE

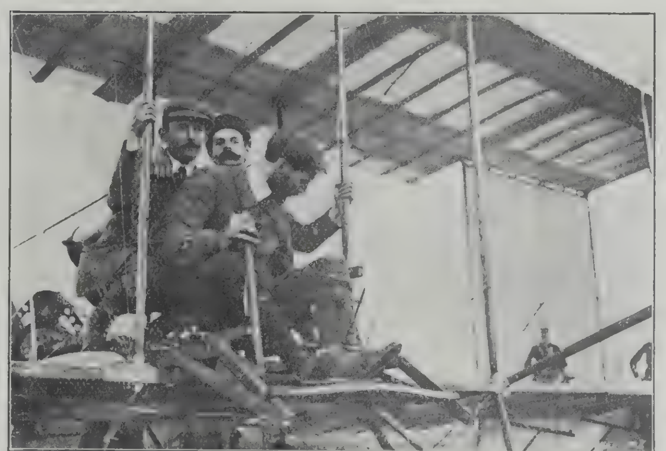
(Long Distance Test)

	Competitor	Machine	Kilometers	Time	Prize, Francs
1.	Farman	Farman	180	3h. 4 m. 56s.	50,000
2.	Latham	Antoinette	154½	2h. 1 m. 19s.	25,000
3.	Paulhan	Voisin	131	2h. 43m. 24s.	10,000
4.	De Lambert	Wright	116	1h. 52m.	5,000
5.	Latham	Antoinette	111	1h. 38m. 15s.	5,000
6.	Tissander	Wright	110	1h. 46m. 52s.	5,000

PRIX DE LA VITESSE, 30 KILOMETERS

(Three Lap Speed Test)

	Competitor	Machine	Time	Prize, Francs
1.	Curtiss	Curtiss	23m. 29s.	10,000
2.	Latham	Antoinette	25m. 18s.	5,000
3.	Tissander	Wright	28m. 59s.	3,000
4.	Lefebvre	Wright	29m.	2,000



Paul Thompson, N. Y.

Fig. 3. Henry Farman about to engage in the Contest in which he carried Two Passengers and made the Circuit in 10 minutes 39 seconds

PRIX DE TOUR DE PISTE, 10 KILOMETERS

(One Lap Speed Test)

	Competitor	Machine	Time	Prize, Francs
1.	Bleriot	Bleriot	7m. 47s.	7,000
2.	Curtiss	Curtiss	7m. 49s.	3,000

COUPE INTERNATIONAL GORDON-BENNETT TROPHY AND 25,000 FRANCS

	Competitor	Country	Machine	Time
1.	Curtiss	America	Curtiss	15m. 50s.
2.	Bleriot	France	Bleriot	15m. 56s.
3.	Latham	France	Antoinette	17m. 32s.
4.	Lefebvre	France	Wright	20m. 47s.

PRIX DE L'ALTITUDE, 10,000 FRANCS

(Soaring Test)

	Competitor	Height		Competitor	Height
1.	Latham	155 meters	3.	Paulhan	90 meters
2.	Farman	110 meters	4.	Rougier	55 meters

PRIX DU PASSAGERS, 10,000 FRANCS, 10 KILOMETERS

(Passenger Carrying Test)

	Competitor	Machine	Passengers	Time
1.	Farman	Farman	1	9m. 52s.
2.	Farman	Farman	2	10m.39s.
3.	Lefebvre	Wright	1	11m.20⅘s.

* * *

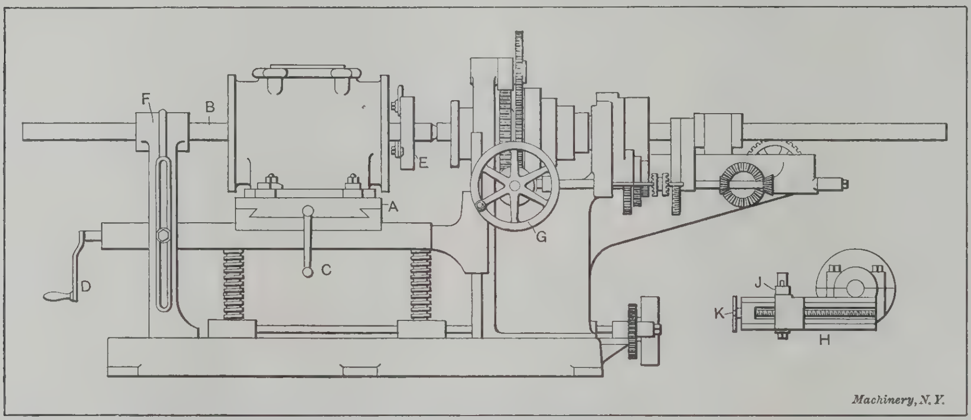
A centennial exposition and world's fair will be held in Winnipeg, Manitoba, in 1912, according to a report by Vice-Consul-General Carl R. Loop.

* The following notes and articles giving records obtained with aeroplanes and airships have previously been published in MACHINERY: Delagrange record, August, 1908; Zeppelin, August, 1908, engineering edition; various aeronautic records, October, 1908, engineering edition; miscellaneous records mentioned in an article entitled "Aeroplane-Type Flying Machine," December, 1908, engineering edition; Wilbur Wright's record, March, 1909; Bleriot's flight across the English Channel, August, 1909

MACHINE SHOP PRACTICE*

BORING CYLINDERS

The type of machine tool used for boring cylinders, and also the method of procedure is determined largely by the size of the work and the quantity which is to be machined. The lathe of both the plain and turret types, as well as horizontal and vertical boring mills are used for this work, and in automobile factories or other shops where a great many cylinders are bored, special machines are often employed. When a common lathe is used, the casting, providing it is too large to be bolted to the face-plate or held in the chuck, is clamped to the lathe carriage, with sufficient blocking beneath it to bring the rough bore in alignment with the lathe spindle. A boring-bar equipped with one or more cutters centrally located, is mounted between the lathe centers and driven by a dog. As the cutters revolve, the work is fed against them by the regular carriage feed. As the boring-bar is the only special tool needed when the work is done in the lathe, cylinders are often bored in this way in shops which do not have a boring machine. If cylinders are to be bored in quantity by this method, a special fixture should be provided for holding them upon the carriage, which is so designed that clamping and adjusting may be quickly done.



Horizontal Boring and Drilling Machine

The Shop Operation Sheet accompanying this number gives an example of small cylinder boring in the turret lathe; the cylinder being of the type used for gasoline engines. By referring to the illustrations and descriptions, it will be seen that the turret, which is, practically speaking, a large tool holder, is equipped with boring tools for both roughing and finishing cuts; also a reamer for finishing the cylinders to size. As these tools may be brought into position as needed by simply revolving the turret, it is possible with such a machine to do work with considerable rapidity.

The accompanying engraving shows the general construction of a common type of horizontal boring and drilling machine, and also the way a cylinder is set up for boring. The table *A* to which the cylinder is clamped, has a horizontal adjustment, both lengthwise and crosswise of the bed, and also a vertical adjustment so that the cylinder to be bored can easily and quickly be set in alignment with the boring-bar *B*. The horizontal adjustments are effected by the handles *C* and *D*, while the table is raised and lowered by power. The boring-bar is supported and kept in alignment with the spindle by an outboard bearing *F*, through which it slides as the cutters in the boring head *E* are fed through the work. This longitudinal movement of the bar is controlled by a feed mechanism which permits the amount of feed per revolution to be varied. Provision is also made for the rapid adjustment of the bar in or out by the hand-wheel *G*. Facing arms *H* may be attached to the bar on either side of the cylinder for facing the flanges after the boring operation. The turning tool is fastened to the slide *J* which is fed outward a short distance each time the star-wheel *K* is caused to turn by a stationary pin against which it strikes.

When setting a cylinder which is to be bored it should, when the design will permit, be set true by the outside of the flange, or what is even better, by the outside of the cylinder itself, rather than by the rough bore, in order that the walls of the finished cylinder will have a uniform thickness. The last or finishing cut, should invariably be a continuous one, for if the machine is stopped, even for a short time, there will be a ridge in the bore at the point where the tool temporarily left off cutting. This ridge is caused by the cooling and the resulting contraction and shortening of the tool during the time that it is stationary. For this reason, independent drives for boring machines are desirable. The position of large cylinders while they are being bored is an important consideration, the disregard of which has often caused trouble. Such cylinders should be bored in the position which they will subsequently occupy when assembled. For example, the cylinder of a horizontal engine should be bored while in a horizontal position, as the bore is liable to spring to an oval shape when the cylinder is placed horizontal after being bored while standing in a vertical position. If, however, the cylinder is bored while in the position in which it will be placed in the assembled machine, this trouble is practically eliminated.

There is a difference of opinion among machinists as to the proper shape of the cutting point of a boring tool for finishing cuts, some contending that a wide cutting edge is to be preferred, while others advocate the use of a comparatively narrow edge with a reduced feed. It is claimed that the narrow tool produces a more perfect bore, as it is not so easily affected by hard spots in the iron, and it is also pointed out that the minute ridges left by the narrow tool are an advantage rather than a disadvantage, as they form pockets for oil and aid in the matter of lubrication. It is the modern practice, however, to use a broad tool and a coarse feed for the finishing cut which is, of course, always right. When boring with machines which are equipped with bars not sufficiently rigid, the tool face will have to be made narrower than would otherwise be necessary, to avoid chattering.

*With Shop Operation Sheet Supplement

* * *

FULTON EXHIBIT, ENGINEERING SOCIETIES BUILDING

The Hudson-Fulton celebration is essentially a recognition of the explorer and the engineer. To show the relation of the latter to the celebration, models of the *Clermont* and other early steamboats, through the courtesy of the Smithsonian Institution, are now on exhibition at the rooms of The American Society of Mechanical Engineers in the Engineering Societies Building, 29 West 39th St. The exhibit includes the *Clermont;* the *Phoenix*, built by John Stevens; and one of John Fitch's early types. Original drawings by Fulton, an oil portrait of Fulton painted by himself, Fulton's dining table, oil portraits and a bronze bust of John Ericsson, models of the *Monitor*, all owned by the society, and Ericsson's personal exhibit at the Centennial Exposition, are also exhibited. Through the courtesy of the Hamburg-American line, a beautiful model of the *Deutschland* shows the highest type of the development of steam navigation.

The model of the *Clermont* represents the boat as she was on her first trip before undergoing alterations to fit her for regular passenger service. The model of the *Phoenix* shows that boat at the time of making the first sea voyage ever made by a steam vessel. The trip was made in 1809, leaving New York on June 8 and arriving in Philadelphia on June 17. Fitch's boat was built in Philadelphia in 1786 and successfully tried on the Delaware River. In 1790 a similar boat carried passengers and freight on the Delaware River for several months.

The exhibition will be open to the public every week day from 9 a. m. to 5 p. m.

* * *

Further experiments in wireless telephony recently carried out in France proved it possible to exchange messages for several hours over a distance of 155 miles. It is proposed to extend the distance, due to the success already attained.

THE SPINNER VARIABLE SPEED INDUCTION MOTOR

On the occasion of the joint summer meeting of the Institution of Engineers and Shipbuilders and the Northeast Coast Engineers and Shipbuilders, in Scotland, the works of Messrs. Mavor & Coulson, Ltd., Glasgow, were opened and among the interesting novelties a three-speed 5 H.P. spinner motor was shown in operation illustrating the method of speed control for electric ship propulsion. The spinner motor, which is illustrated assembled and disassembled in Figs. 1 and 2, is an interesting example of the most recent development in the direction of variable speed induction motors. Although the spinner motor has been upon the market for some time, it is not so well known as more commonly used types, and a description of the machine exhibited, will undoubtedly be of general interest to our readers.

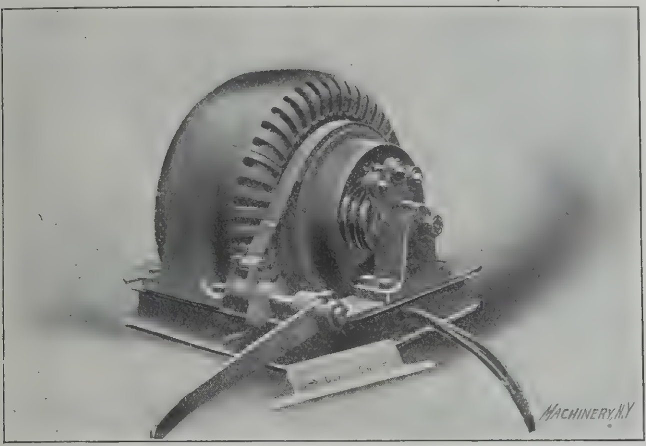


Fig. 1. Mavor & Coulson, Ltd., Variable Speed Induction Motor

There are two elements in the motor which may revolve, these being the ordinary rotor which is mounted on the main shaft, and the spinner. The spinner is cylindrical in form and fits between the annular space between the rotor and the stator. The spinner is carried on end brackets adapted to revolve freely upon extensions of the bearings of the main shaft. A brake wheel is provided on one of these end brackets over which is fitted a metal brake band whereby the spinner can be prevented from rotating when desired. On the outside periphery of the spinner there is a closed circuit or squirrel cage winding, and on the inner surface, next to the main driving motor, there is a winding like that on the stator. In order that the current may be supplied to this winding it obviously is necessary to connect the terminals through slip or collector rings. Both windings on the spinner are placed in slots in the usual manner.

It will be seen from the foregoing description that the machine consists of two motors concentrically arranged around the common axis. Starting from the outside and taking each part separately we first have the ordinary stator winding and then there is the closed circuit or squirrel cage winding on the spinner which together with the stator constitutes one motor. Next on the same spinner there is a winding which only differs from the stator winding in that it can revolve and that its ends are connected to slip rings. Lastly there is a squirrel cage motor mounted on the main shaft and revolving inside the spinner. The current is delivered from an outside source to the primary winding of the fixed stator and spinner respectively, passing in each case through a simple reversing switch.

To illustrate the action of the spinner motor it may be assumed that the primary winding on the spinner is wound so as to give four pairs of poles and that the stator proper of the other or outside motor is provided with eight pairs of poles. If, now, a brake is applied to the spinner and current at a periodicity of 25 cycles be supplied to the primary winding through the collector rings, the speed of the rotor and consequently the driving shaft (if we neglect the slip) will be 375 revolutions per minute. If the stator winding of the other motor with its eight poles be connected in circuit and the spinner simultaneously released, the latter can be made to revolve in the same direction as the main motor, or in a reverse direction. The direction is determined by the reverse switches. Now, since the outside stator has eight pairs of poles the synchronous speed of the spinner can be only 187.5 revolutions per minute, and it is evident that according to the direction of the rotation of the spinner this speed can be added to or subtracted from the 375 revolutions per minute of the rotor obtained when the spinner is held stationary. If, then, the switches are closed so that the spinner revolves in the same direction as the main motor the shaft speed becomes $375 + 187.5 = 562.5$ revolutions per minute. If the reversing switches are closed so as to cause the spinner to revolve in the opposite direction to the motor, then the lowest shaft speed is obtained, or $375 - 187.5 = 187.5$ revolutions per minute.

From the foregoing it is seen that this induction motor has three speeds which are obtained without the use of resistance

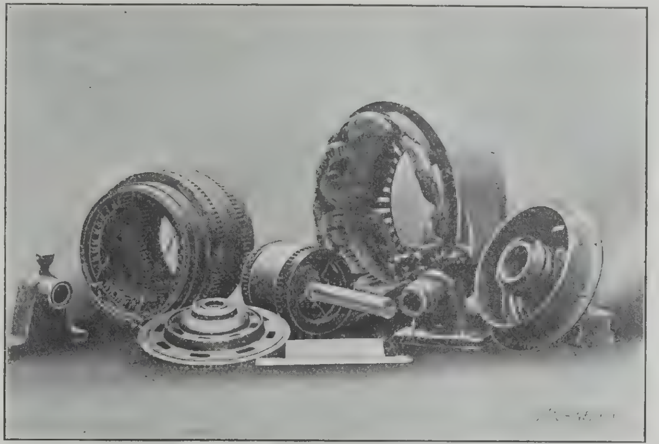


Fig. 2. Mavor & Coulson Variable Speed Induction Motor Disassembled

in the rotor circuit and without varying the periodicity of the main circuit, and without pole-changing in the ordinary sense.

Fig. 3 shows an interesting application of the spinner motor, wherein it is employed for starting purposes and not for speed regulation. By the use of the spinner, the motor may be started without the employment of resistances or an autotransformer, and the load may be taken up gradually and without jerks, which is of great importance with colliery haulage gears, etc.

A simple switch is all that is required to manipulate. The rotor which is of the squirrel cage type is coupled to the

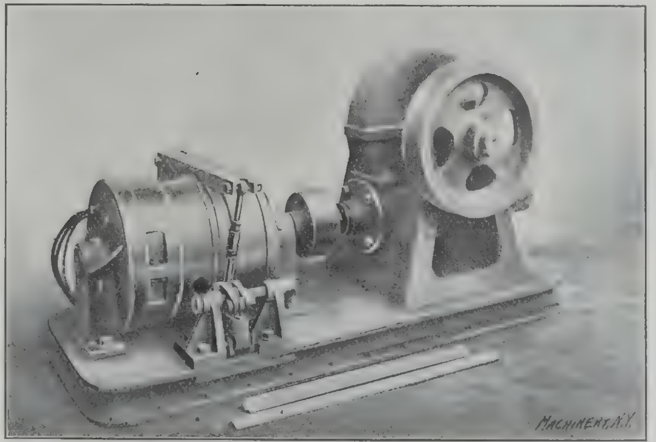


Fig. 3. Application of One-speed Spinner Motor to Haulage Gear

driving shaft of the haulage gear. The spinner which encircles the rotor, and which is free to revolve when the brake is released carries a three-phase winding. The current is supplied to the collector rings of the spinner and at the moment when the gear is switched on, the hand brake is off so that the spinner is free to revolve. Now, if the spinner is free to revolve, it is evident that so long as the brake is off there is no tendency for the rotor to revolve, for in order to turn, it must exert a torque to overcome the load to which it is mechanically connected. If, however, the brake is applied so as to gradually stop the spinner, the rotor works up to speed and drives the haulage gear. This device may also be employed for reducing the speed of haulage when required.

DRAWING DIES FOR HOLLOW RIVETS

CHARLES WESLOW*

One day I stood in the doorway of a large factory "rubbering," when the boss came along and inquired of me if I wished to see anyone in particular. "No," I replied, "I am a toolmaker, and have just come from a neighboring shop looking for a job, and in passing I stopped to see what was going on in the building where I happened to learn my trade." "You learned your trade here?" he asked. I assured him that I did, but that I had been apprenticed to a concern which previously occupied the building, but which had since gone bankrupt. "Well!" he said, "if you are a toolmaker, I'd like you to come into the office." I went in with him, but under the impression that he probably knew of a place where I could get a job. Instead, he handed me a sample string of hollow rivets, such as those shown at *A* Fig. 1, which had just come from the die, and asked me if I thought they could be drawn out longer. An idea as to how this could be done instantly struck me, and as it would not be expensive, I was quite prompt in assuring him that the rivets could be lengthened without difficulty. He asked me if I would take the job fixing up the dies, or making new ones, and guarantee that the rivets would come a sixteenth of an inch longer. I told him that I would if it was worth while. He then asked me, with an air of incredulity, if I would do it on contract, and as I assented, he gladly agreed to pay me fifty dollars for the job, remarking that he had already spent about two hundred dollars on those dies, but to no avail. Before leaving to go home for my "kit" he remarked that all their "store" dies and presses gave pretty good satisfaction, except this gang die for rivets, the punch of which would break through before the work even reached the third operation.

I reported the following morning and after examining the work of the dies in question, and watching their movements for awhile, I took down the set, and decided to change the shape and size of the second and third dies and punches. Fig. 2 shows the construction of the punches and dies as they were, each alternate die being shown in section. *K* indicates the "knock-outs." The stripper is not shown. Fig. 3 shows the changes made in both the punches and dies.

These dies were laid out to make two rivets at one throw. In Fig. 2 the order of the various operations, as originally performed, are indicated by the numbers there given. In the first operation a boss is created, the size of which is found by experiment (in some shops this is called "finding" the blank). The punches and dies number 2 then work this boss into a conical shell. The third operation was evidently intended to reduce the diameter of the cone, which was then converted by the next set of dies into a straight shell. The bottom was then cut out by set number 5, while the next and last dies blanked out the finished rivet. This die failed because the punches would break through the bottom of the shell before the latter was completed.

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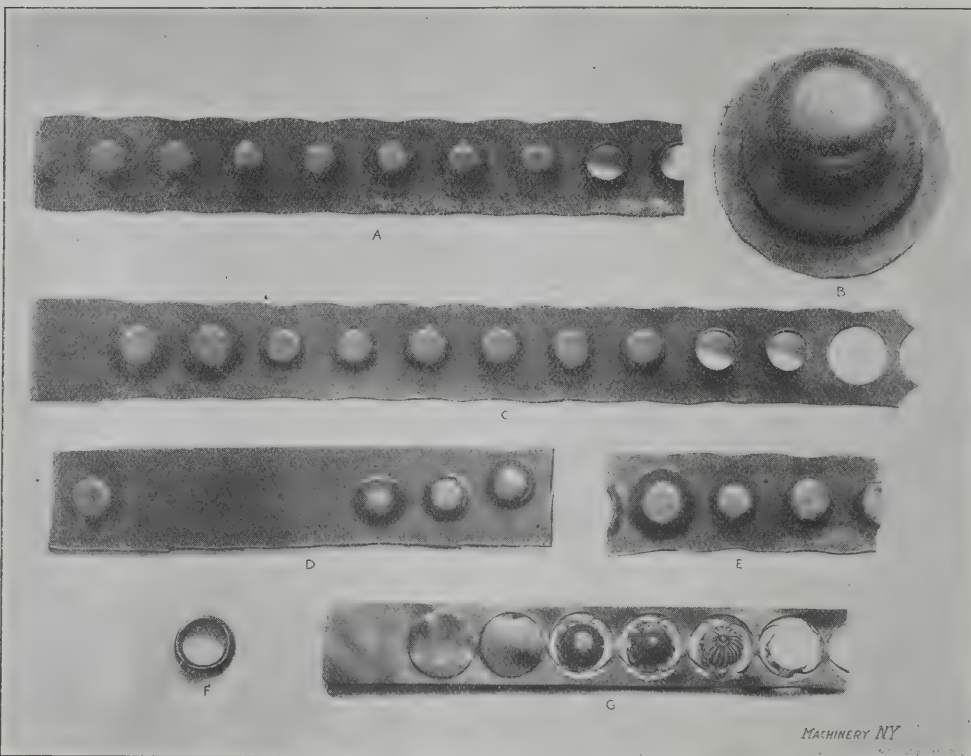

Fig. 1. Samples showing the Results obtained by both the Smooth and the Stepped or Roughed Punches

While I knew from experience just what was wanted, I really couldn't go right ahead and fix the dies in a couple of hours, and then have the nerve to ask for the "fifty." So, after much trying to conceal my zest and knowledge, I decided to "kill time" by doing "government work," as some of my own equipment needed repairs. After tinkering around four days, the boss came around and asked me, again in an incredulous manner, if I was confident of success. "Yes," I said, "as far as the dies are concerned," but I added that I didn't know how I'd manage to collect the "fifty." (I really wondered if he would pay it.) "Well," he said, "if you make those dies work in a week, you'll get besides your fifty dollars the price of a pleasant evening with your best girl. So, spurred on by this prospect, I decided that I would make one week the limit and then collect.

By referring to Fig. 3 the changes made in operations numbers 2 and 3 may be seen. It will also be noted that the original operation number 4 is omitted. Instead of making any alterations concerning the location of the fifth and sixth operations, I merely removed the number 4 dies and punches from the press, leaving it to the boss to decide about renewing the whole set, by his own die-maker, since my work ended as soon as I could demonstrate the style of die to use. Therefore the fourth operations on the string *A*, Fig. 1, are merely dummies in string *C*, which is a product of the dies after I had changed them. The stock used was number 18 of the cheapest cold roll that could be bought, but it made no difference how cheap the metal was when it was drawn by the improved method. The original dies, however, only worked successfully on good stock.

In another factory I have also seen the same trouble on brass shells, such as shown at *B*, Fig. 1. In this case the punch should simply have been made rough. I also happened to be poking in the junk pile, and picked up the piece shown at *D*. While I made no inquiry as to its origin, I did keep it as a keepsake, inasmuch as it showed someone's experiments on the same problem as the hollow rivets. This die-maker also got "stuck," since the punch broke the bottoms as shown in the engraving.

Referring to the particular style of punch I substituted for the third operation (see Fig. 3), it can be readily understood that as the punch is irregular in size it has a tendency to imbed its shoulders into the side of the shell, thus pulling the stock into the die as well as pushing it in, and distributing the strain throughout all parts of the shell. Of course this reduces the thickness of the stock on the sides, but when I showed the boss my sample he said that it was good enough for the purpose and just what he wanted. It might be well to explain that the steps on these punches are shown exaggerated in the illustration.

Fig. 4, at *A*, shows an end view of the string *E*, Fig. 1, with the finished shell sawed in half. This sectional view shows the shape of the shell after it is drawn by the stepped punches. Nothing could be done, however, until the die and punch for the second operation were properly formed, as shown in Fig. 3, where they are shown nearly straight. An-

other mistake my predecessor made was in continuing the conical shaped die until the fourth operation was reached, and then changing to a straight die. The new die, as will be seen, begins in the second operation to form a nearly straight shell out of the conical boss, and then in the third the stepped punches are applied as previously described. If it were necessary to produce a still longer rivet, the first operation would need to be changed so that there would be a larger boss, and the whole gang would need to be separated more. Figs. 1 and 4 at *F* and *B*, respectively, show a rivet made by the improved dies, slightly curled over to prove its pliability after the stretch.

At *G*, Fig. 1, is shown a sample of a string of brass ornaments as they were manufactured in a fancy goods factory

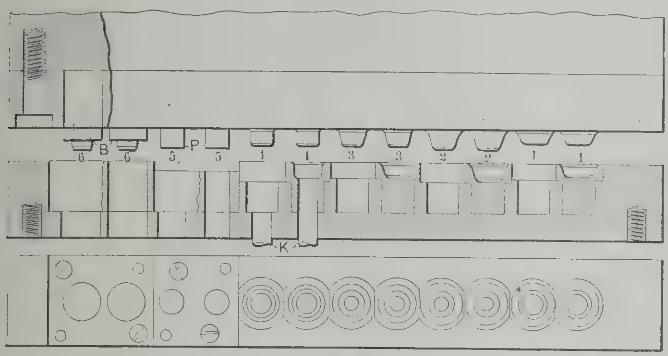

Fig. 2

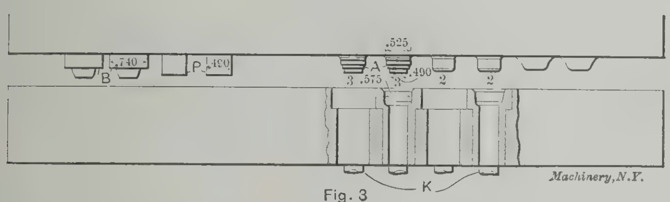

Fig. 3

Fig. 2. Punch and Die in which the Piece shown at A, Fig. 1, was formed. Fig. 3. Improved Punch and Die with Stepped Punches

I had been with. In this case the job is similar to the rivets, because they are also knocked out on a progressive die, but they are pointed cup-shape and easier to form. The first operation is to nearly cut the blank, leaving enough stock to keep it connected with the ribbon, in order to facilitate handling it. Six dies are used: the first and second to nearly blank out; the third to form a cup; the fourth to "coax" the cup to a point; the fifth to corrugate it and further its point, and the sixth to cut it through and trim it.

It may interest some readers to know that taper shells made of brass, silver or aluminum are made just the reverse

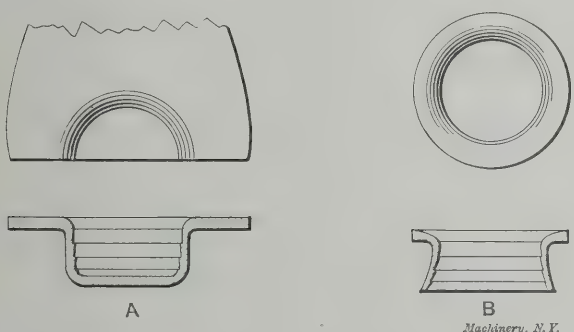

Fig. 4. Sectional View of Drawn Rivet Shell, showing marks left by Stepped Punch

of the way the improved dies described in the foregoing make hollow rivets. The shells are first drawn to the shape of a cone pulley, the number of steps depending on the length and taper of the shell. The corners of the steps are left rounded. This irregular sized shell is then placed beneath a drop-press containing a punch and die having the required taper, and it is "ironed out." The punch is prevented from sticking in the die by an adjustable collar that strikes the die harder than the taper punch. This collar is made in the form of two lock nuts.

SELDEN PATENT UPHELD

Decision was filed in the United States Circuit Court for the Southern District of New York, by Judge Hough, September 15, sustaining the famous Selden patent on gasoline automobiles. The decision holds that the claims of the Selden patent, on which suit was brought, are valid and infringed. The suit is that of George B. Selden and the Electric Vehicle Co., against the Ford Motor Co., C. A. Duerr & Co., O. J. Gude Co., John Wanamaker and others, Société Anonyme des Anciens Etablissements, Panhard, Levassor, Andre Massenat, and Henry and A. C. Neubauer. The decision is voluminous, reviewing the entire case and concluding that the invention of George B. Selden is a pioneer invention of great merit. It holds that Mr. Selden is first in this art and broadly construes claim 1 so that it covers all gasoline automobiles. Claim 1 reads as follows:

"The combination with a road locomotive, provided with suitable running gear, including a propelling wheel and steering mechanism, of a liquid hydrocarbon gas engine of the compression type, comprising one or more power cylinders, a suitable liquid fuel receptacle, a power shaft connected with and arranged to run faster than the propelling wheel, an intermediate clutch or disconnecting device and a suitable carriage body adapted to the conveyance of persons or goods, substantially as described."

The Selden patent No. 549,160 was granted November 5, 1895, and, therefore, expires in 1912. The remarkable feature about this patent aside from its broad claim is that the application was filed in the Patent Office May 8, 1879, and the application was kept alive during that period by the technicality of the patent laws, which allow applications to be renewed year by year provided an amendment is filed within two years of the date of rejection.

George B. Selden was a lawyer in Rochester, N. Y., during the seventies and spent his spare time experimenting with horseless carriages. After six years of hard work and the construction of five or six different engines he produced a carriage that would run, and finally applied for a patent on the same, submitting a model which is still in the Patent Office. (See MACHINERY, May, 1903.)

The American automobile manufacturers who will not be adversely affected by the decision are the licensees comprising the Association of Licensed Automobile Manufacturers, as follows:

American Locomotive Co., Apperson Bros. Auto Co., Autocar Co., Buick Motor Co., Cadillac Motor Car Co., Chalmers-Detroit Motor Co., The Columbia Motor Car Co., Corbin Motor Vehicle Corp., Elmore Mfg. Co., Everitt-Metzger-Flanders Co., H. H. Franklin Mfg. Co., Haynes Auto Co., Hewitt Motor Co., Hudson Motor Car Co., Knox Auto Co., Locomobile Co. of America, Lozier Motor Co., Matheson Motor Car Co., Packard Motor Car Co., Peerless Motor Car Co., The Pierce Arrow Motor Car Co., The Pope Mfg. Co., Royal Tourist Car Co., Alden Sampson, 2nd, Selden Motor Vehicle Co., F. B. Stearns Co., Stevens-Duryea Co., Studebaker Auto Co., E. R. Thomas Motor Co., Toledo Motor Co., Walter Automobile Co., Waltham Mfg. Co., Winton Motor Carriage Co.

Representative of defendant automobile makers assert that the decision will not affect their business, and that the case will be carried to the Circuit Court of Appeals, and if necessary to the Supreme Court.

* * *

According to *Frankfurter Zeitung*, the German railways occupy the leading position among the railways of the world in regard to safe traveling. The following figures apply to the year 1907 and give the number of passengers killed and injured per million passengers:

	Killed	Injured
Germany	0.08	0.39
Austria-Hungary	0.12	0.96
France	0.13	1.18
England	0.14	1.94
Switzerland	0.20	1.04
Belgium	0.22	3.02
United States	0.45	6.58
Russia	0.99	3.93

In Germany ninety-two per cent of the railways are owned and operated by the government.

RECALESCENCE AND ITS RELATION TO HARDENING

J. E. STOREY*

Everyone interested in the hardening of steel will have noticed the increasing frequency with which reference is made to the recalescence point of steel, in articles appearing in the technical press from time to time. It is only during the past few years that this peculiarity in steel has come to the front, and there are still very many who do not possess even a rudimentary knowledge of the subject. The somewhat obscure references one usually sees in articles on hardening will not help the man in the hardening shop very much to a better understanding of the matter, and therefore an elementary explanation of the phenomenon will be welcome to many. It may be quoted that, as a matter of history, hardening has been done with more or less success, from the days of the famous Damascus swords up to only a comparatively short time ago, without anyone having discovered that steel possessed such a peculiarity as recalescence, but nevertheless its relation to hardening has always existed, and its discovery paved the way for much scientific investigation into a subject that had been previously controlled by rule of thumb.

Curve made by a Recording Pyrometer, showing the Recalescence Points

The "recalescence" or "critical points" (also sometimes designated Ac. 1 and Ar. 1) that bear relation to the hardening of steel, are simply evolutions that occur in the chemical composition of steel at certain temperatures during both heating and cooling. Steel at normal temperatures carries its carbon, which is its chief hardening component, in a certain form—pearlite carbon to be more explicit—and if heated to a certain temperature a change occurs and the pearlite carbon becomes cementite or hardening carbon. Likewise, if allowed to cool slowly, the hardening carbon changes back again to pearlite. The points at which these evolutions occur are the recalescence or critical points, and the effect of these molecular changes is to cause an increased absorption of heat on a rising temperature and an evolution of heat on a falling temperature. That is to say, during the heating of a piece of steel a halt occurs, and it continues to absorb heat without appreciably rising in temperature, at the recalescence point, although its immediate surroundings may be hotter than the steel. Likewise, steel cooling slowly will, at a certain temperature, actually increase in temperature although its surroundings may be colder.

The accompanying illustration shows a curve, taken on a recording pyrometer, in which the recalescence points are well developed. From this it will be seen that the absorption of heat occurred at a point marked 733°C on the rising temperature, and the evolution of heat at 724°C on the falling temperature. The relation of these critical points to hardening is in the fact that unless a temperature sufficient to produce the first action is reached, so that pearlite carbon will be changed to hardening carbon, and unless it is cooled with sufficient rapidity to practically eliminate the second action, no hardening can take place. The rate of cooling is material and accounts for the fact that large articles require to be quenched at higher temperatures than small ones.

A very important feature is the fact that steel containing hardening carbon, *i. e.*, above the temperature of recalescence, is non-magnetic. Anyone may demonstrate this for himself by heating a piece of steel to a bright red and testing it with an ordinary magnet. While bright red it will be found to have no attraction for the magnet, but at about a cherry-red it regains its magnetic properties. This feature has been taken advantage of as a means of determining the correct hardening temperature, and appliances for its application are on the market. Its use is certainly to be recommended where no installation of pyrometers exists; the only point requiring judgment is the length of time an article should remain in the furnace after it has become non-magnetic. This varies with the weight and cooling surface, but may be tabulated according to weight, leaving very little to personal judgment.

It is difficult to quote reliable temperatures at which recalescence occurs, as the observation of different investigators do not show concordant results, probably owing to the lack of uniformity in the means of measuring the temperatures. It varies with the amount of the carbon element contained in the steel, and is much higher for high-speed than for ordinary crucible steel. Special electric furnaces are generally used for obtaining recalescence curves, but with care it can be done in an ordinary gas furnace, with a suitable pyrometer. All that is necessary is to bore a blind hole in a piece of the steel to be treated, to form a pocket to receive the end of the pyrometer. This must be of sufficient length to cover the resistance coil in the end of the pyrometer. The specimen should then be put in the furnace, with the pyrometer in, of course, the gas applied, and, if the furnace is allowed to heat up very slowly toward a temperature of say 750° C., the recalescence curve will be developed, if the pyrometer is a recording one. In the same way, if the furnace is allowed to cool slowly it will be seen that at the second recalescence point, the specimen gives off heat and even increases in temperature for a time. Experiments of this kind are scarcely practicable for the average hardening shop, but when it is desired to find the lowest hardening temperature for a piece of steel, the magnet can be used to advantage.

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* * *

BRASS SPIRALS MADE ON SCREW-CUTTING MACHINE

The illustration shows four brass spirals supplied to the United States government by the Screw Cutting Company of America, 17th St. and Sedgley Ave., Philadelphia, Pa. The spirals were made by cutting a 1½-inch pitch thread, ¼ inch wide, on hard drawn seamless brass tubing 3¾ inch diameter,

Brass Spirals made from Tubing by the Screw Cutting Co. of America for the United States Government

No. 18 British wire gage (0.049 inch). The spirals are used for reinforcing hose, and the longest was cut from a brass tube ten feet long. The company was able to do this work rapidly and efficiently on its special screw cutting machines (see MACHINERY, April, 1909, for illustrations of products), and is prepared to produce similar work in brass, steel or other metal, and on any length of tubes that can be made and shipped. It is of the opinion that the proposition by any other process than its own would have been very difficult and costly.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

ACCURATELY LOCATING WORK ON THE FACE-PLATE

The object of this article is to show how easy it is to accurately locate work on the face-plate by the use of plugs and size blocks. The way in which the casting shown in Fig. 1, which is part of the milling fixture, Fig. 5, is located on a lathe face-plate so that it may be bored central with the end bearings, will be explained. By this method all chances of error which might occur in trying to center such a casting in the old way are eliminated. The function of the casting, when in the assembled fixture, is to hold the part shown in Fig. 4 while a groove *G*, 1/16 inch wide and 1/32 inch deep, is being milled on the inner surface, which is spherical. As this groove must have the same depth at each end, the reader will readily see the importance of accurately locating the

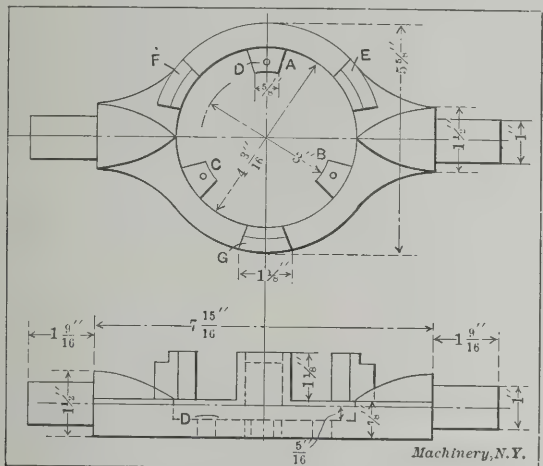


Fig. 1. Work to be Located with Reference to the End Bearings

fixture casting for the boring operation. A plug *A*, exactly one inch in diameter, was first inserted in the lathe spindle as shown in Fig. 2. The two V-blocks, also shown in this engraving, are used on regular tool work, and when made were planed accurately to 1⅝ inch wide, 1⅝ inch long, and 1⅝ inch from the bottom to the center of a one inch plug placed in the V. The distance, therefore, from the sides to the center of the blocks is 13/16 inch, and as there is a 1-inch plug in the spindle, the block to be used between the plug and the parallel upon which the V-blocks are to rest when

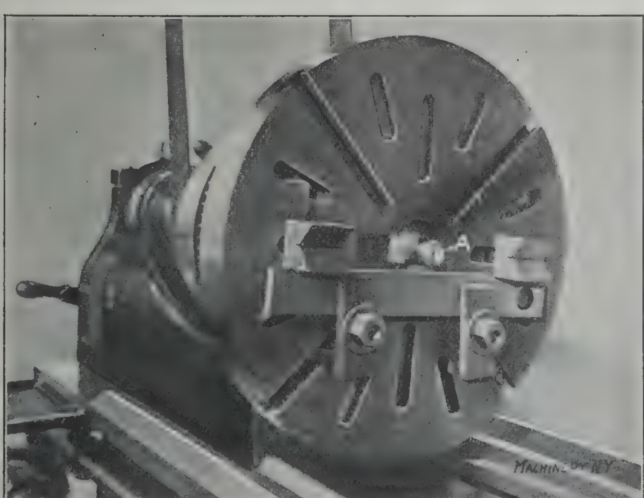


Fig. 2. Setting Parallel and V-blocks from a Central Plug

setting the parallel, would be 13/16 inch minus 1/2 inch, or 5/16 inch. By referring to Fig. 1, we find that the distance between the shoulders of the end bearings is 7 15/16 inches. One-half of this amount is 3 31/32 inches, which minus half the plug diameter leaves 3 15/32 inches, which is the required size of the blocks to be used between the plug and the V-block, only one of which was set in this way. When the casting was placed in the blocks, it was carefully set against the block which had been previously located. The other block was then brought up against the shoulder of the bearing on the opposite end. These V-blocks happened to be tapped in the bot-

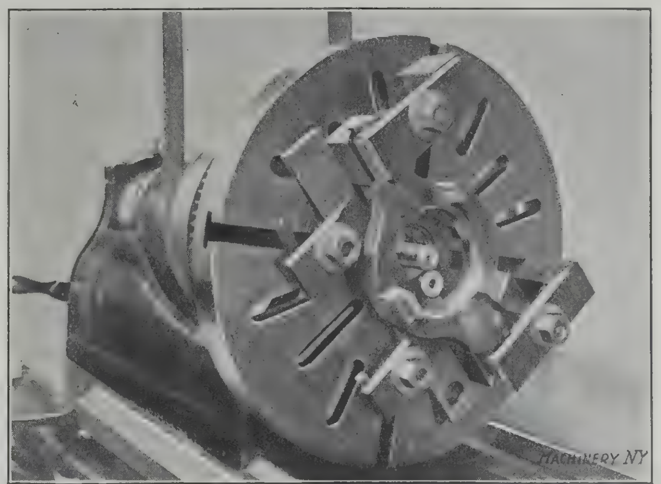


Fig. 3. Use of Central Plug and Ring Gage for Sizing Projections located 120 Degrees apart

tom for a ⅜-inch screw, which, with clamps to hold them against the parallel, made it easy to locate them. The casting was set parallel with the face-plate by the use of a surface gage. Fig. 3 shows the work after the three projections

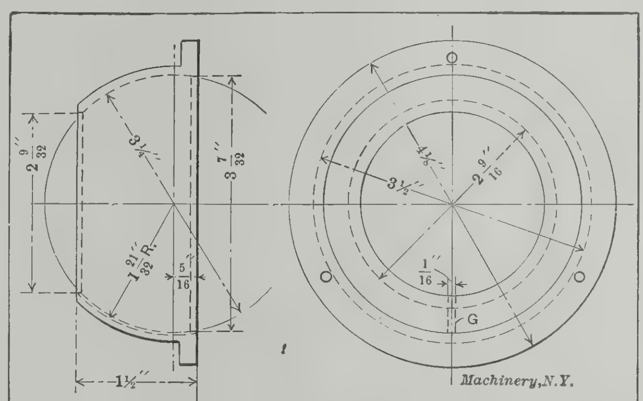


Fig. 4. Casting which is held in the Fixture, Fig. 5, while a Groove is being milled in its Spherical Surface

A, *B*, *C* and the surface *D*, Fig. 1, had been bored and faced. The inner projections were bored to a 3-inch circle by using a standard one-inch ring as a gage (as shown in Fig. 3) which, when placed against the plug, gave a radius of 1½ inch. By referring to the elevation in Fig. 1, it will be seen that the surface *D* must be 5/16 inch below the center line. As the distance from the base of each V-block to the center of a 1-inch plug resting in the V is 1 5/8 inch, 5/16 subtracted from this amount leaves 1 5/16, which is the thickness of the block to set between the point of the tool and the face-plate when setting the tool for the finishing cut. The projections *E*, *F*, and *G* were turned to fit a ring 5 inches inside diameter. A plug was made having one end 3 inches in diam-

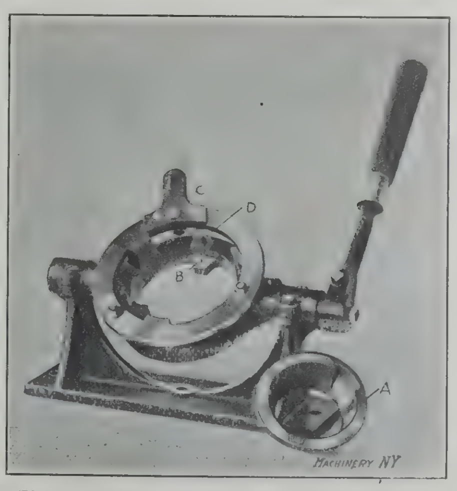


Fig. 5. Fixture of which the Casting shown in Fig. 1 forms a Part

eter to fit the inside of the lugs *A*, *B*, and *C*, Fig. 1, and the other end turned to fit the 3 7/32-inch bore of the spherical casting, Fig. 4. This plug was for locating the piece to be milled so that the pins in the projections *A*, *B*, and *C* would be in such a position that when the work was subsequently located by them, the center of its spherical surface would coincide with the axis of the rotating part of the fixture. Two of these locating pins were also set in a line parallel with the center line of the fixture. All this work was done before removing the casting from the face-plate. It will be understood that if the work should become shifted in any way it can be readily and accurately reset again by this method.

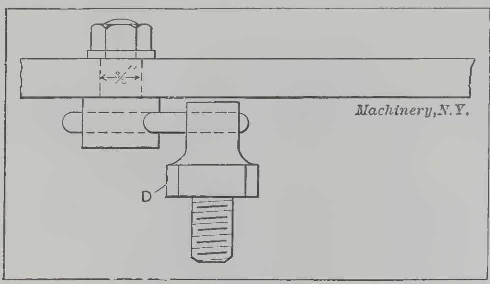


Fig. 6. Detail of Clamping Device for Fixture shown in Fig. 5

The completed fixture is shown in Fig. 5, with a sample of the work held by it at *A*. This illustration, as well as the detail Fig. 6, shows the locking device by which the work is clamped in place. After the casting is located by pins *B* which fit into holes bored in the casting flange, it is secured by a movement of the ring *C* to the right, which causes three locking screws *D* to turn simultaneously, and clamp against the flange. ALBERT C. SAWYER.

Dorchester, Mass.

TWO GAS ENGINE JIGS

In selecting the two jigs shown in the illustrations from among those in use in the manufacture of a well-known gas engine, I have digressed from the usual custom of choosing only the best for description, believing that there is as much to be learned from the mistakes as from the successes. These jigs while embodying some very good features, are offered as examples of jigs possessing points to be avoided.

Fig. 1 shows a piston boring jig. It is a well-designed jig in every respect except one, and that is in the method of clamping the work. This method is the one usually followed for securing cylindrical work, either in a jig or to the drill press table, and it is very effective—so effective, in fact, that more or less work is spoiled by being either cracked or sprung. Gas-engine pistons are necessarily rather light, and to hold them tight enough and still not injure them requires more care than the average operator can be depended upon to exercise. It is almost impossible to avoid springing the pistons, and often they take a permanent set. As an improvement in this and similar jigs I would suggest that the work be clamped longitudinally. This would probably not be as convenient as the method shown, but it should be as effective and certainly would not injure the work.

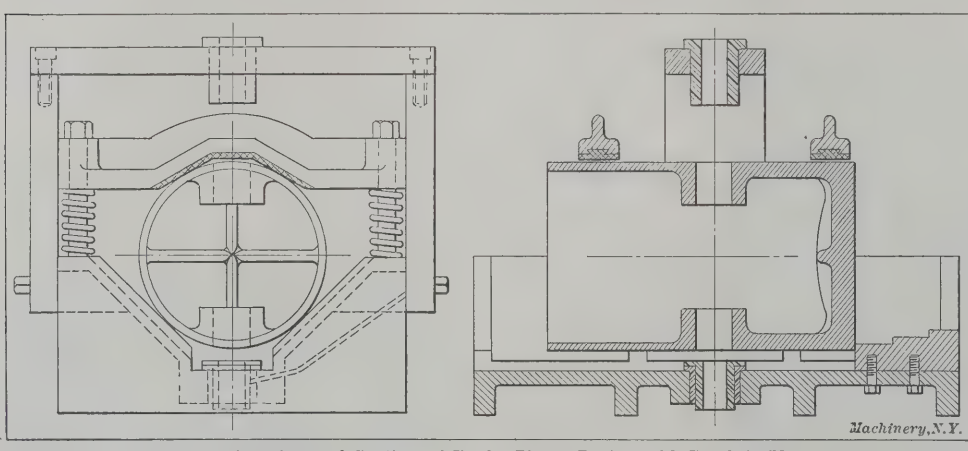


Fig. 1. Elevation and Section of Jig for Piston Boring with Work in Place

A good point of the jig is the springs to hold the clamps up while changing the work. In places where springs can be employed, they will save much time in avoiding the removal of the clamps each time the work is changed. Another good point of this jig is the babbitt metal facing of the clamps, which prevents scarring the pistons.

The fixture shown in Fig. 2 is a chuck for connecting-rods, for use on the milling machine. The method of clamping is quite ingenious, as the turned heads are used both to align and hold the rods. This looks all right on the face of it, but in actual practice it was found necessary to make the addition of adjusting screws under the heads of the rods to prevent them turning on their respective axes under uneven cuts. This added so much to the time of chucking that practically all the advantage gained by the manner of clamping was overcome. J. F. MIRRIELEES.

Cincinnati, O.

CLEANING MICROMETERS

In my travels I have seen many mechanics trying to get emery and grit out of micrometer screws and nuts, either by washing them in benzine, alcohol, kerosene, or other oils, or alkalis, or by digging out the dirt with pine sticks, or pith. At one time mine became clogged with emery, and I sent them to the manufacturer. It cost me 50 cents besides prepaying all charges. When they were returned to me they were worse than ever, so I decided to experiment. I placed the screws in benzine to remove the oil which had been collecting the emery. Then the parts were heated just enough to be held comfortably in the hand, and a coating of beeswax was applied to the screw and nut. The screw was then placed in the nut, after it was cold, which forced all the small particles of dirt out with the surplus wax, and closed up the slots, avoiding the possibility of dirt and emery becoming clogged in them. A small thin coating of wax was therefore left between the screw and nut. The screw was then removed from the nut, and all surplus wax removed, and a drop of thin oil applied. Anybody having trouble with their micrometers will find this remedy O. K. Mine have been in daily use for nearly three years, with the same coating of wax, and are to-day in good condition. FRANK G. STERLING.

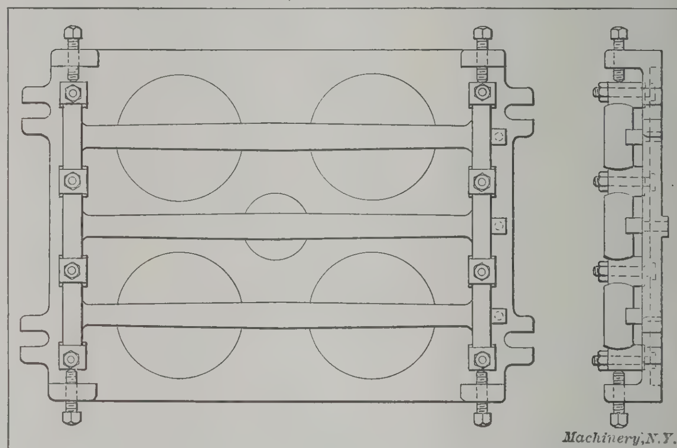


Fig. 2. Design of Fixture for Connecting-rods, which proved Objectionable

Franklin, Mass.

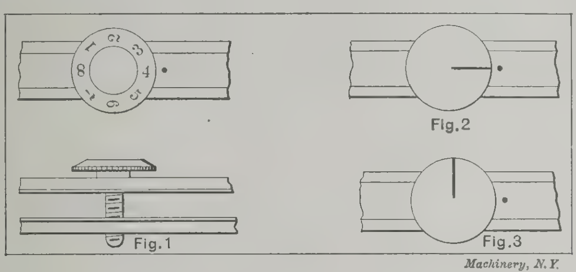
GRADUATED SCREW HEADS ON DRAWING PENS

Having had some difficulty in getting all the lines on a drawing of the same width, it occurred to me that it would be a good scheme to graduate the screw heads of the drawing pens, so they could always be set for some pre-determined width of line before beginning to draw. With this object in view, a bevel was turned on the upper faces of the screw heads which were stamped with numbers from 1 to 8, as shown in the plan view in Fig. 1, and a center punch mark was made on the blade of the pen, against which to

read the numbers. After the different pens in the set of instruments are marked, they can be adjusted by trial on a waste piece of paper until they all draw the same width of line, and a record made of the reading of each screw, as shown in the accompanying table, there being two records for each pen, one of which is for light lines, and the other for shade lines. There is not much use for a shade line adjustment on the compass pens, as nearly all draftsmen

	Small Compass	Large Compass	Straight Line
Light line..............	4	1	7
Shade line..............	6	3	1

shade their circles by springing the needle leg, but it is of occasional use in drawing short arcs. The record shown in the table can be hung up on the wall, placed in the cover of the instrument case, or anywhere that is convenient for reference. As the pens are sharpened, or the screws wear in the thread or under the shoulder, the record for the pen settings will have to be altered at quite long intervals, depending on how much use each pen gets. Some makers supply straight line pens with a graduated screw head somewhat larger than usual, but mine were of the kind that is ordinarily supplied with drawing instruments, and were rather



Ruling-pen Screw-heads Graduated to obtain Lines of Uniform Width

small in diameter, so the numbers were not very large; however, I find it a great help. Anyone not having facilities for stamping numbers can place two ink marks on the screw heads—one red mark for light lines and one black mark for shade lines; or only one ink mark can be used on the screw head, having it point as in Fig. 2 for light lines, and as in Fig. 3 for shade lines. This ink mark scheme is not original with me, as I am indebted to R. A. Gleason for it. The marks will last quite a while, as the ink is on the flat side of the screw head that is not supposed to be handled.

Brooklyn, N. Y. WALTER GRIBBEN.

CHUCKING TRANSMISSION SLEEVES FOR INTERNAL GRINDING

A special steady-rest and chuck for use in the grinder when grinding a certain make of automobile transmission sleeve, is shown in the accompanying illustrations. Fig. 1 shows a

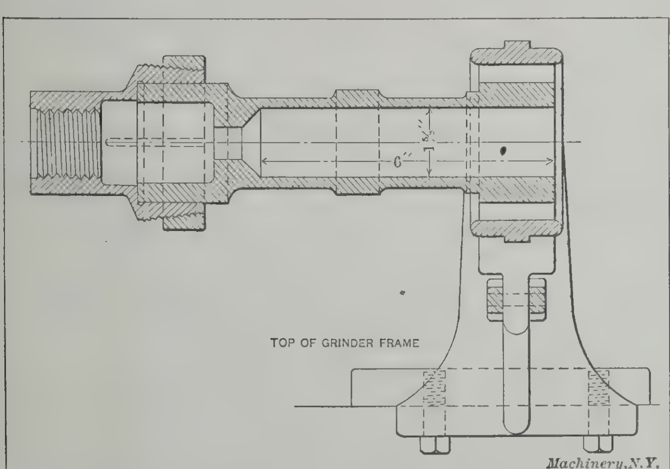


Fig. 1. Plan in Section of Grinder Rest and Chuck with Work in Place

plan view in section of the chuck and rest with the work in place, and Fig. 2 an end elevation. The sleeve, which is a steel drop forging, is finished all over, after which the hole 1⅝ by 6 inches long is ground to fit a plug gage. This method of holding the work enables it to be quickly set so that the hole will be finished perfectly concentric with the outside surfaces. The chuck which holds one end of the sleeve is of the ordinary spring collet type. It has six milled slots, and the chucking end has a taper of 7 degrees

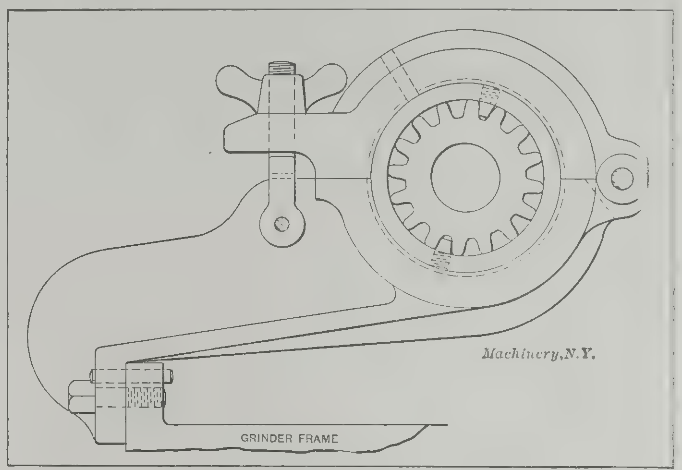


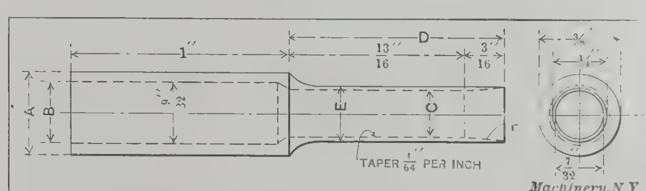
Fig. 2. End Elevation of Rest, showing Method of Holding End of Work

which is threaded. A machine steel ring-nut with holes for a spanner wrench is threaded to fit the taper part of the nut. Both the chuck and the ring are hardened and ground to size. During the grinding operation the outer or gear end of the sleeve is held in a one-piece bronze ring. This ring is provided with a tongue which is a neat working fit in a groove in the steady-rest. As shown in the end elevation, this rest has a hinged cap which is held in place by a hinged clamping bolt provided with a suitable wing-nut. Bolts and dowel pins secure the rest to a rib on the grinder frame. In the bronze ring there are two steel studs which are flush with the outside diameter and which protrude inward as shown in the end view. These studs are shaped to fit the teeth of the gear, thus causing the bronze ring to turn with the sleeve during the process of grinding. With this form of rest, the chucking, grinding the inside of the sleeve, and removing it, is all done in about eight minutes, which is seven minutes less than formerly required. There is also little danger of error because of an unskilled or careless operator, as he cannot make a mistake in chucking the work.

M. HEARTILLHEN.

A DRILL FOR PAPER

The accompanying engraving illustrates a tool which is remarkable for its simplicity and efficiency. This tool was developed in a jobbing shop where tools were being made for loose leaf ledger work. There was considerable trouble with the tools for punching the ledger leaf holes, it being difficult to get the punches to cut "clean," through any considerable thickness of paper, so an attempt was made to drill the holes instead of punching them. It was soon discovered that the paper could not be drilled with any kind of lip drill, because, no matter how the lips were shaped, they would catch and tear the paper. After considerable experimenting, the tool



A Tool for Cutting Holes through Paper

shown in the engraving was developed, and it was found to be far superior to the ordinary method of punching. This tool requires but little explanation. To make it, take a piece of tool steel and catch it in the lathe chuck, allowing it to extend from the chuck far enough to permit of its being turned the full length, and then cut off. Next turn the diameter A allowing 1/64 inch for a finishing cut. Turn down the end to the diameter E, and to the length D, again leaving 1/64 inch for a finishing cut. Now drill through the full length of the

tool, a hole slightly smaller than *C*, so that it may be trued up with the boring tool. Before finishing this hole, bore out the clearance hole *B* which should be 1/16 inch larger than *C* to allow the scrap or paper cuttings to pass through freely. Next finish the hole *C*, making it 1/64 inch per inch taper, the largest part of the hole being at the back. This hole should be 1/32 inch smaller than the outside diameter *E*, which is the exact size of the holes to be drilled in the paper. The diameters *A* and *E* are next finished, *E* being made 0.001 inch smaller at the back than at the cutting end. Taper the mouth of the tool as shown at *F*, bringing it to a fine edge at the outside diameter. The tool may now be cut off and hardened. It should be hardened in oil, and drawn to a dark brown at the cutting edge, this color running off gradually to a blue at the back end of the tool. If care is exercised in hardening, there will be no necessity for grinding or lapping. The tool may be used in the drill press, and it should run about 1,500 revolutions per minute. The press or speed lathe in which the tool is used should have a hollow spindle to allow the paper cuttings to pass through. If, however, a hollow spindle machine is not available, a chuck with sufficient space to permit the cuttings to pass out between the jaws, may be used, or a special holder may be made, of simple design, to serve the purpose. One who sees this tool work for the first time will be surprised to observe how clean and freely it will cut.

C. W. D. and W. B.

ADJUSTABLE ELECTRIC LAMP BRACKET FOR THE SHOP

In many shops it is found to be quite a problem to construct an electric lamp bracket for the bench, which can easily and quickly be adjusted to any height and position. The Cincinnati Shaper Co. uses a bracket which fills the bill and the cost of which is trifling. The illustrations, Figs. 1 and 2, show this bracket assembled and in detail. The same reference letters are used in each illustration for corresponding parts, so that the construction of the bracket may be more easily understood. The small cast iron angle-plate *A* is screwed to the wall. The top of this plate, as shown in the plan view, Fig. 1, is serrated so that the arm to which the lamp is attached, will remain in the desired position. These serrations are cast in, and the only machining done to this

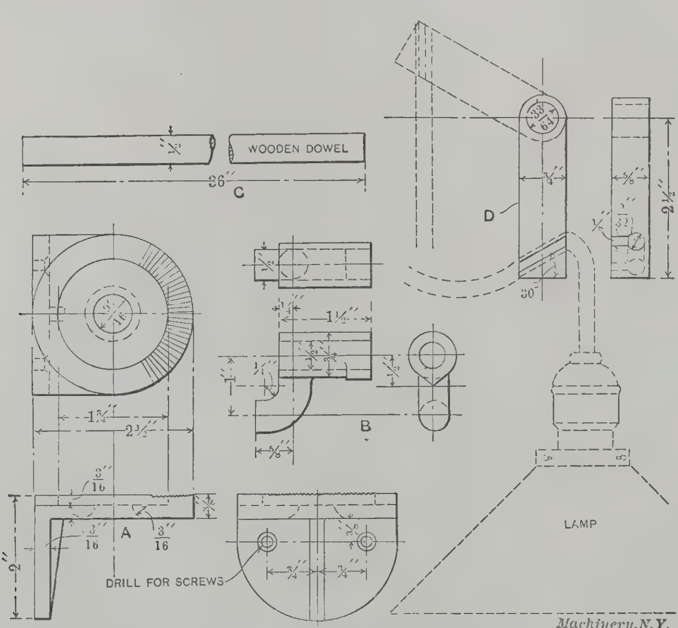


Fig. 1. Details of the Adjustable Electric Light Bracket shown in Fig. 2

piece is the drilling of the screw holes for fastening it to the wall or window sill. The small casting *B*, which is attached to one end of the wooden arm *C*, has a curved end which fits into a hole in *A*. A ½-inch hole is cored into casting *B*, and into this hole the wooden dowel *C*, which is about 36 inches long, is driven. As will be seen by referring to the end view, the casting *B* has a sharp V-shaped projection on the bottom of the front end; this rests in the serrated part of the angle-plate. The piece *D*, located at the end of the arm *C*, is of fiber. This is drilled 1/64 inch larger than *C* to permit it to slide back and forth easily. The hole through which the lamp wire passes is drilled at an angle of 30 degrees, as shown in Fig. 1, to prevent the wire from slipping. A slot is milled into this hole on one side so that

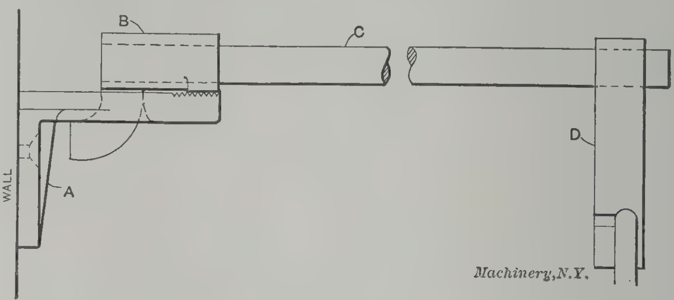


Fig. 2. Simple Design of Adjustable Electric Light Bracket

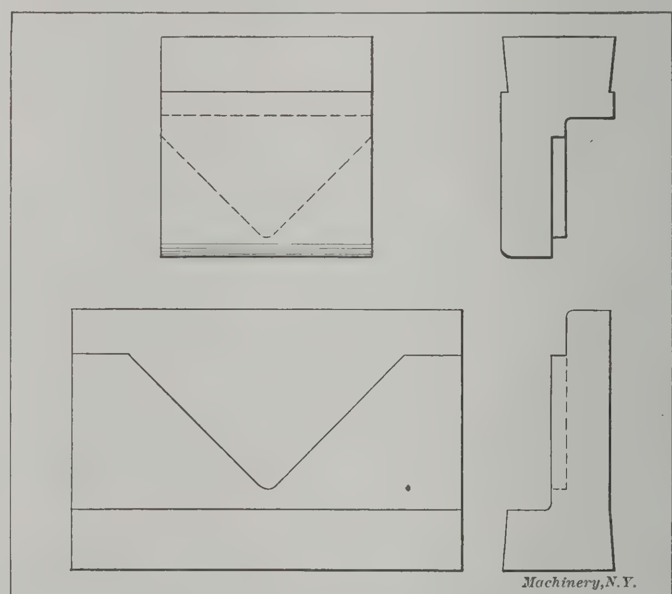
the wire may be placed into position. By raising the block, as shown by the dotted lines, the lamp can easily be adjusted to any height.

H. DONNERBERG.

Cincinnati, O.

A BENDING DIE

A type of punch and die that is adapted for bending at right angles, edgewise, soft steel strips, in size from ⅛ ×1-inch to ⅜ × 1-inch, is shown in the accompanying engraving. This tool commends itself from the fact that it is of simple design, easy to make, and that, in bending the stock,



Die for Bending Soft Steel Strips Edgewise

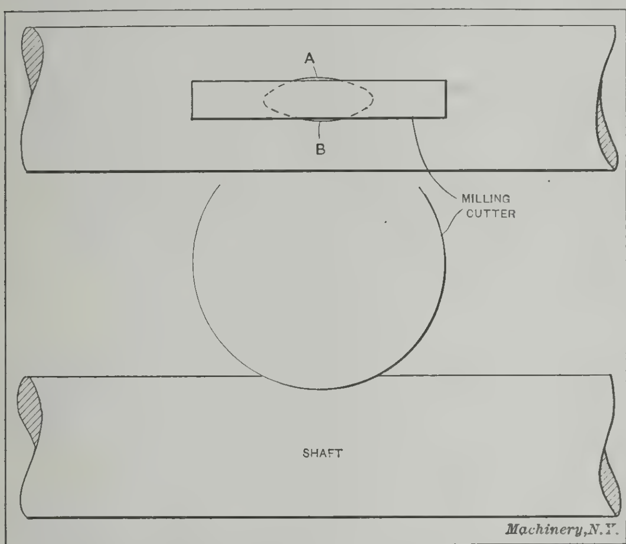
the inner angle does not increase in thickness to any appreciable extent. When accurate work is required and no increase whatever in thickness at the bend is allowed, the punch and die may be locked together by extending a part of the punch over the rear of the die. This will eliminate any tendency of the two members springing away from each other in action. As the stock bent in this die was in long strips and extended beyond the die, a stop (not shown) was attached to the side of the bolster. This tool is run in a press with a stroke of 4 inches. Both the punch and the die are planed at an angle of ten degrees to fit the holder, and they are both hardened.

ENGINEER.

CENTERING SHAFT WITH MILLING CUTTER WHEN KEYSEATING

The micrometer gage for centering work with milling cutters, described by Mr. Chapman in the July number of MACHINERY, would do this work with considerable precision were it not for the fact that in the present rush and hurry in manufacturing probably 80 per cent of the milling cutters do not run perfectly true on the arbor; and, in that event, there would be great chance that the accuracy of the micrometer would be useless. Assuming that the cutter runs perfectly true, then undoubtedly the tool referred to is all right

from a standpoint of accuracy; but I fear that in a majority of shops, it would be too fine a tool to suit the foreman, who is naturally supposed to be anxious to do things in a hurry. I recall one such foreman, from whom I received many a good lesson on economy and rapid production, and one of these was on how to locate a shaft with the cutter when milling a spline or key-seat. This method works equally as well on a planer as on a milling machine. After the shaft and the tool or cutter is in place, start the machine and either plane or mill a flat spot across the top of the shaft as wide or a trifle wider than the key-seat; then set the tool by this finished surface. For example, when a shaft is to be set central with a milling cutter, the latter is first sunk into the work as shown in the accompanying engraving. The shaft is then fed crosswise under the cutter and a spot milled as indicated by the dotted lines in the plan view. After this spot is milled a trifle wider than the width of the cutter, the work may be set by sighting down over the top of the cutter and adjusting the work until the same amount of



Method of Setting a Milling Cutter Central with a Shaft

milled space shows at *A* and *B*. The cutter should be revolving while this adjustment is being made so in case it runs out laterally, the high sides will appear at the bottom in such quick succession that it may be set the same as a true running cutter. After the first shaft is located, the operator should not move the cross-feed screw until all of the shafts are finished. Of course, on the planer the locating spot will have to be machined for each shaft. This should not be done by feeding down a broad nose tool, for while any kind of a tool may be used, it must be fed crosswise in order to finish a surface which is parallel with the planer platen. I have used this method for years and find it satisfactory both in regard to time and accuracy. Therefore I pass it along hoping that it may be of help to someone.

Bridgeport, Conn. H. E. Wood.

ACCURATE BORING ON THE HORIZONTAL BORING MILL

Among the standard tools of to-day in most machine shops is found the horizontal boring mill, and although not as old as the lathe, planer, and some others, it is equally as necessary on some classes of work as these older and more standard tools; but in operating this tool the workman generally finds great difficulty in obtaining an accurate hole of a very great length, especially if the equipment, including bars and guide bushings, are not absolutely new, in addition to being accurate. A simple equipment that is generally used is shown in Fig. 1. The bar *A* is made of annealed tool steel, and the cutter *B* is held in a central position by the wedge *C* and a fitting on either side of the bar. The bushing *D* is bored to fit the bar and turned to suit the hole in the yoke of the machine. This bushing is held in the yoke by two set-screws which are spotted into it to prevent any slipping or turning without subjecting the bushing to any great strain. Here lies the chief difficulty to which the writer desires to draw particular attention, and acquaint the reader with a very desirable and successful remedy.

As the bushing is always in the same position, a large portion of the wear comes on the bottom. This wear, in turn, allows the cutter to run closer to the table as it proceeds away from the machine until it reaches the yoke; then the work receives the full benefit of the worn or inaccurate bushing and a hole is produced which is not parallel with the table and of an elliptical shape, the vertical axis being the longest because of the play the bar has in the bushing. Even when the bushing is made a suitable running fit, a hole will show

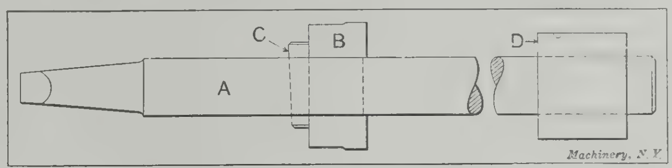


Fig. 1. Boring-bar with Solid Bushing

from one to four one-thousandths difference between the horizontal and vertical axis. From the foregoing it is readily seen that the object required is to maintain the bar in a perfectly central position with the spindle at all times, just enough freedom being provided to allow the bar to turn.

Fig. 2 shows a form of split adjusting bushing which is very old in principle, but which produces excellent results in this case. The outside bushing *A* is turned to suit the hole in the yoke of the boring mill, and it is bored parallel to receive bushing *B* which, in turn, is bored taper to receive bushing *C*, the inside of which is bored parallel to the exact size of the bar. This inner bushing is split in three parts. Two washers or end plates *D* are required, whose bore is 1/16 inch longer than largest bar; these are each secured to bushing *A* by four tap bolts, as shown, and they are also drilled and tapped for two set-screws *E*, which bear against bushing *B*. Two of these set-screws are required on one end for tightening and two on the other for loosening bushing *B*.

The pressure sometimes applied on these set-screws is enough to nearly burnish the bar with heat, when a particularly fine finish is required, so that the allowance for a running fit is reduced to an absolute minimum, and the resulting cut will be just as true as the machine, less the wear of the

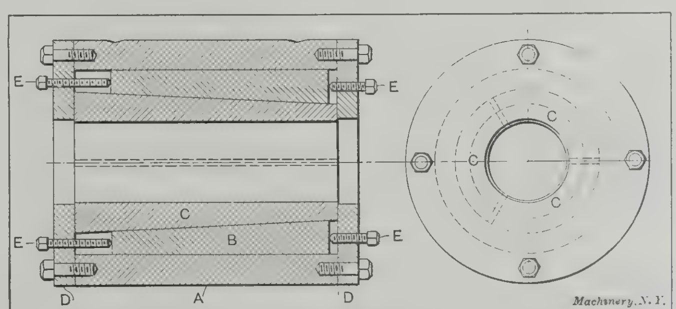


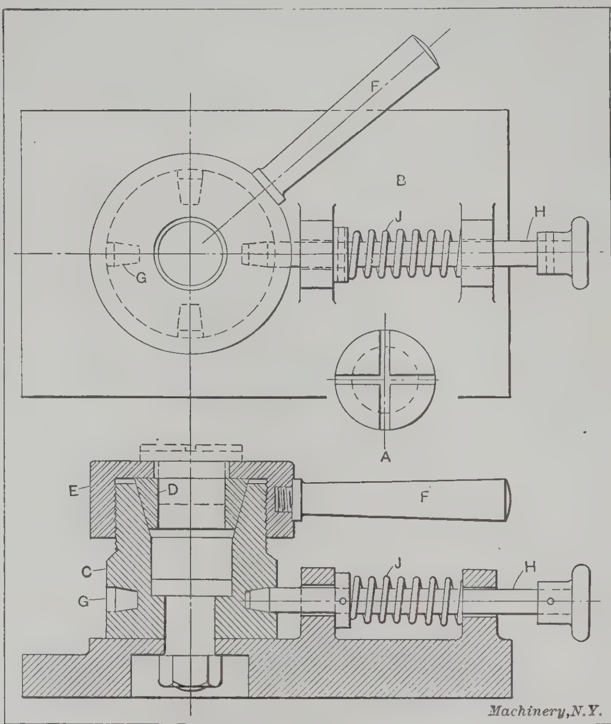
Fig. 2. Split Adjustable Bushing for the Boring-bar

tool, which will vary slightly according to the quality of the steel in the tool compared with the material being cut; when these both agree, accurate work will result. The construction of the device is not confined to any set dimension or taper, but it is preferable that the taper be quite abrupt to obtain quick adjustment, to allow for a large take-up for wear, and to obviate too much of a wedging effect. The different diameters of bars are taken care of by having a number of split bushings *C*, the inside diameters of which correspond with each bar. R. S. F.

MILLING FIXTURE FOR SMALL CYLINDRICAL WORK

A chuck for holding a small plug, a plan view of which is shown at *A*, while grooves are being milled at right angles across its upper face, is shown in the accompanying engraving. This chuck consists of a base *B* which is fastened to the milling table. On this base is pivoted a cylinder *C* which is threaded on the upper end, and turned tapering on the inside to receive a conical bushing *D* which fits the taper of the

cylinder. This bushing is split so as to allow it to be sprung together when forced down by the cover *E* which is threaded to fit the cylinder *C*. This cover is turned by means of the handle *F*. The taper of the bushing and the recess in *C* should be of such an angle that the two pieces will not grip and hold fast. An angle of from thirteen to fifteen degrees is about right. In the lower part of the cylinder *C* there are



Milling Fixture for Holding the Plug shown in the Plan View at A, while the Grooves are being milled

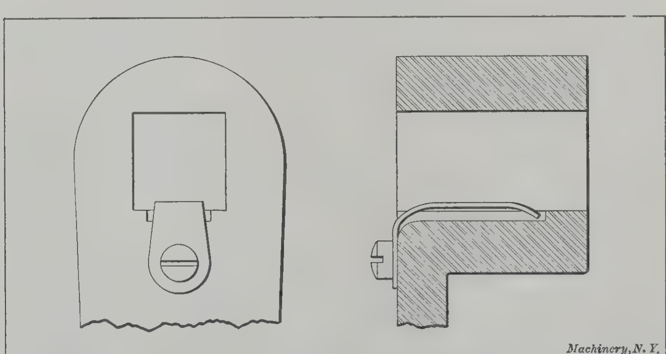
four holes *G* which serve for spacing the cuts. On the base *B* there is mounted a pin *H* which is held in one of the holes *G* by means of the spring *J*.

The operation of the fixture is as follows: By turning the handle to the left, the cover raises and the bushing *D* slips up and expands. The plug is then dropped in place, as shown by the dotted lines, and the handle turned to the right, which forces down the cover *C* and bushing *D*, causing the latter to spring together and grip the plug. A cut is then taken across the top. Then by pulling back the pin *H* and turning the handle *F* to the right until the next hole *G* comes in line with the pin *H* the work is indexed for the next cut. Then the handle is turned to the left again, and the plug released and another inserted.

This chuck could be used for many different kinds of work by having the proper bushings. E. B.

SECURING CRANK HANDLES

The crank handles supplied by many builders with their machine tools, soon find themselves as much at home on the floor as on the squared end of a feed-screw. In the course of



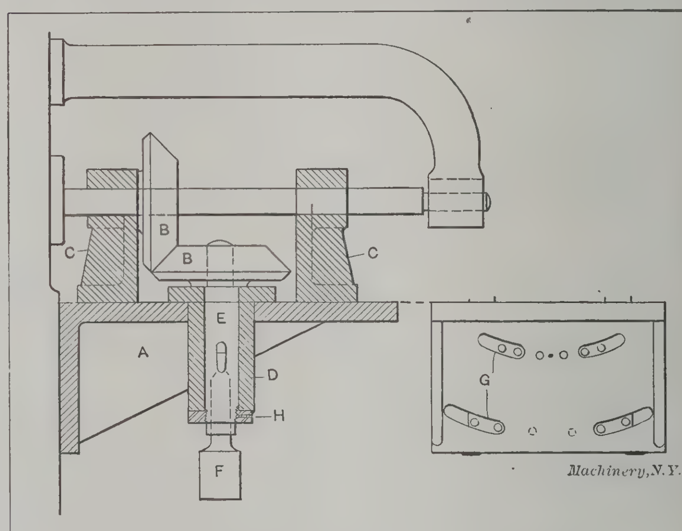
Crank Handle with Pressure Spring which prevents it from coming off.

a year, a great deal of time is spent in picking up these fallen handles, to which must be added the cost of new ones to replace those of cast iron which still are sometimes foisted upon us. Half an hour's work will fix any handle so that it will not fall off. As seen by the illustration, a small groove is chipped part way through the hole for the squared end of the screw, and a bent flat spring is fastened to the handle. Unless the handle is very loose on the feed-screw, the spring need bear on the latter with but little pressure to keep it in its place. Then it can be slipped on and off almost as readily as without the spring, when it is necessary to do so to place it in a convenient position.

Middletown, N. Y. DONALD A. HAMPSON.

MAKING A VERTICAL MILLING ATTACHMENT

Much has been done of late years in the way of developing the vertical attachment for milling machines, as this little attachment permits one to do a great variety of work. There are, however, thousands of milling machines in the field today which do not possess one of the model up-to-date vertical attachments, and therefore I shall give a brief description of how one of them was made in a rush one day when the occasion demanded it. As the draftsman and patternmaker both happened to be on a vacation, it fell to me to rig up the attachment with the things I had at hand, which I proceeded to do by retiring to the casting house, where the two brackets *C* and the flanged casting *D* were found. After some more rooting around the shop I dug up an old pair of miter gears that had been discarded from an experimental job. Then, taking one of the regular angle irons *A* away from a planer, I proceeded to lay out and cut the radial slots *G* shown in the end view. These were to allow the vertical



Vertical Milling Attachment made from Miscellaneous Scrap

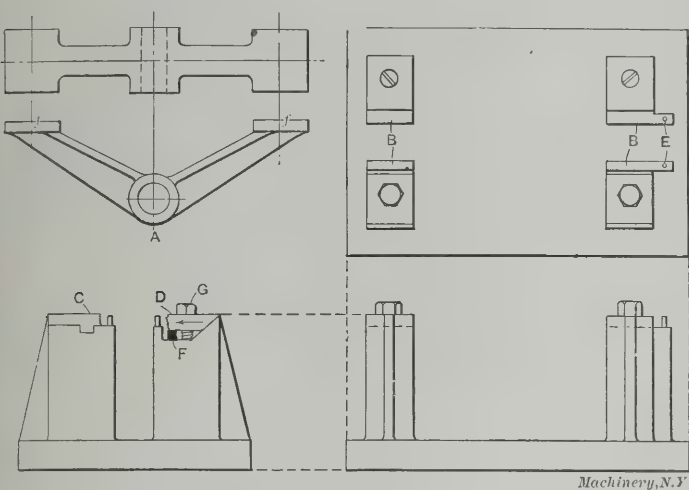
spindle to be tilted. During the time this was going on, another man was boring out and turning the casting *D*, but to no particular size, just enough metal being removed to clean it up. The feet of brackets *C* were also planed. The angle iron *A* was put on a drill press and drilled and bored to a driving fit for bushing *D*. The spindle *E* was next made, from a piece of scrap shaft, to match casting *D* and gear *B*, and then collar *H* was made to suit the spindle. When this was done, we were ready to assemble. To do this it was necessary to drill several holes in this milling machine column, and right here is where many of the machine owners and old-school mechanics would have objected and said: "Don't drill any holes in that machine; every hole you drill knocks $10 from its value if you ever want to sell it." Now let me say to them that a machine is in a shop for the purpose of earning all it can for the owner, and it is not an ornament to be kept nice so that it will sell for $19 more some day. Therefore it is up to the foreman to get all he can out of every machine, but of course he has no right to needlessly destroy it. Then again, in this particular case, the vertical attachment would add ten times more to the value of the machine than the holes could possibly take off. When assembling the attachment a makeshift boring-bar to bore out the castings *C* was used. We had to bore the holes larger and bush them down to match our regular arbor; the gear *B* had also to be bushed down. This article is offered in hopes that it may possibly suggest to someone else a method of getting around some of their milling machine troubles. Of course we know

that vertical attachments usually come now with new machines, but nevertheless there are thousands of milling machines without them, the owners of which do not care to expend the amount of money that one of them costs.

Bridgeport, Conn. H. E. Wood.

A SHAPER FIXTURE

The engraving shows a shaper fixture used for holding the bracket *A* while the feet are being planed, as indicated by the finish marks *f*. This bracket rests upon the surfaces *B*, and it is held in place by jaws *C* and *D*, and the pins *E*, which prevent the thrust of the cut from shifting it endwise. The steel stationary jaws *C* are held in place by a tongue which is recessed into the jig body, and by the fillister head screws as shown. The steel jaws *D*, which are finished on one end to an angle of 45 degrees, are forced against the work by tightening the cap-screws *G*. The inside ends of the jaws *D* rest upon stationary blocks *F* of solid rubber. Both sets of jaws are hardened, and the working faces are serrated. This forms a very simple but effective way of holding the bracket, as the jaws *D* will have a downward and an inward movement when they are tightened, which, with the serrated faces, will cause the bracket to be gripped firmly. Jig and Tool Designer.



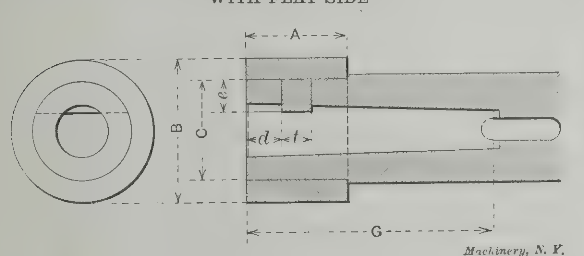
Shaper Fixture for Holding a Bracket

DRIVE FOR DRILLS AND REAMERS

Recently there have come upon the market several devices that are designed to eliminate the tang troubles commonly experienced in connection with the use of Morse standard taper shanks on drills and reamers for severe service. The apparent demand for some method to increase the strength of taper shanks suggests that a device which has been in use for a number of years in the factory where the writer is located, may be of interest. The accompanying engraving and table, taken from the writer's notebook, gives the dimensions of standard Morse sockets fitted with a key, which engages with a flat side on the drill or reamer shank. This key is inserted by milling a slot across the socket near the end, so that the slot will cut through into the tapered bore. A piece of flat steel, or a Woodruff key, is driven tightly into this slot, and then the outside of the socket, including the projecting part of the key, is turned off for a short distance from the end, and a steel collar driven over it. This collar retains the key in place and reinforces the socket. The shanks of the drills and reamers are milled flat on one side so as to fit against this key when driven into the socket. For milling the shanks so they will be interchangeable, master shanks are used, which are put on centers in the milling machine and used to set the milling cutter by. The master shank is then removed and the tool to be milled put on centers and milled with the tool setting obtained from the master shank. The flat on the side of the shank is milled parallel to the axis of the shank. For use in connection with the sockets described, the shanks are made without any tang upon the end, but in all other respects they are made according to the standard Morse tapers. As stated, this device has been in use for a number of years and the results are satisfactory. Bruce C. McAlpine.

Jackson, Mich.

DIMENSIONS OF SOCKET AND KEY FOR MORSE TAPER SHANKS WITH FLAT SIDE

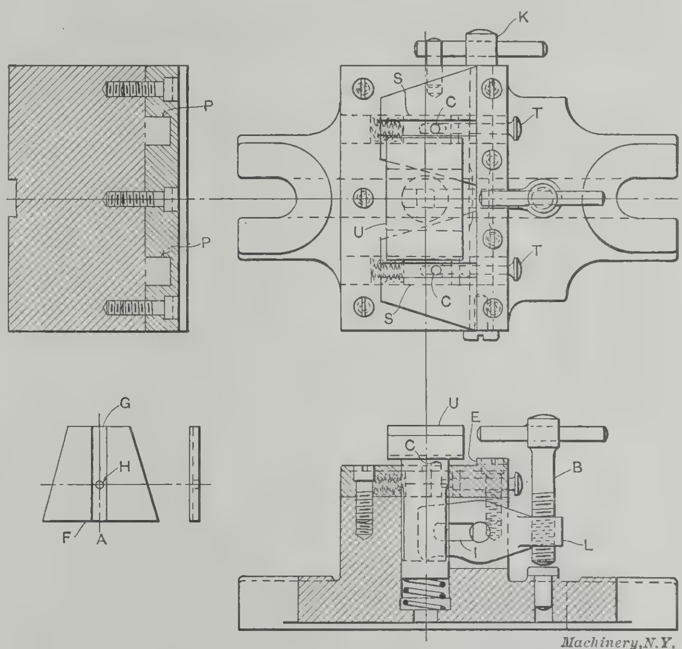


Taper No.	A	B	C	G	d	t	e
1	$\frac{7}{8}''$	$1\frac{1}{4}''$	$\frac{7}{8}''$	$2\frac{1}{8}''$	$\frac{5}{16}''$	$\frac{1}{4}''$	$\frac{9}{32}''$
2	$1\frac{3}{8}$	$1\frac{3}{4}$	$1\frac{3}{8}$	$2\frac{9}{16}$	$\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{16}$
3	$1\frac{3}{8}$	$1\frac{3}{4}$	$1\frac{3}{8}$	$3\frac{3}{16}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{5}{16}$
4	$1\frac{3}{8}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$4\frac{1}{16}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{13}{32}$

EFFICIENT TYPE OF MILLING FIXTURE

The fixture shown in the engraving was designed to mill the groove *G* in the work which is shown at *A*. This groove is 0.187 inch wide and 0.042 inch deep, and it is necessary that it be central with the hole *H* and at right angles with the face *F*. The fixture was designed to hold two of these pieces at one time. It is composed of a cast-iron base on the top of which is a steel plate held by fillister-head screws and located by the tongues *P*. These tongues or projections are cut away in the center, and into these spaces are fitted the slides *S* which carry a centering pin *C*, which fits the hole in the work. The slides, by means of the compression springs behind them, force the face *F* of the work against the shoulder *E* thus locating this face at right angles with the feed of the table. When the pieces are being placed over the pins *C*, the slides *S* are operated by the thumb-plungers *T*. The T-clamp *U* holds the two pieces of work, one on each side. It is operated by screw *B* through the lever *L*, and a spring underneath keeps it up when no work is in the fixture. The shaft *K* upon which *L* fulcrums extends through the fixture and it is milled flat on opposite sides at a point where it passes through the lever, to a little less than the width of slot *I*. When this shaft is turned 90 degrees from the position shown, these flat sides are in alignment with this slot and the lever can then be pulled out clear of the clamp so that the latter may be lifted out of the fixture. The advantages of a clamp of this style are that it can be quickly removed, thus making it easy to brush away chips. The milling arbor can also be brought close to the work, thereby allowing the use of small cutters when necessary.

Athol, Mass. W. A. Sawyer.



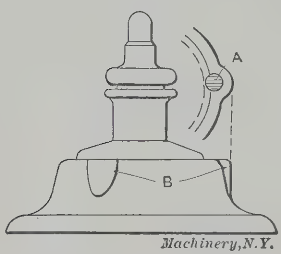
Milling Fixture with Efficient Locating and Clamping Devices

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

HOLDER FOR THE INK BOTTLE

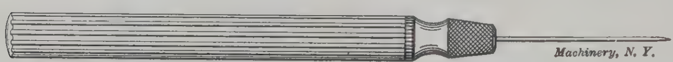


The ink-bottle holder illustrated in the April number of MACHINERY is very similar to one brought out and patented in Scotland some three years ago, the difference being that instead of using a retaining spring to hold the bottle, round india-rubber inserts are used instead. These rubber retainers are inserted as shown at *A*, the bosses *B* on the side of the base being drilled to receive them.

BOTTLE HOLDER.

SCRIBER FOR SMALL HOLES

It is sometimes necessary to scribe holes in places where an ordinary scriber cannot be used, as through holes 1/16 inch diameter in a thick piece of metal. I overcame this difficulty by using a jewelers' pin-vise, with a darning needle held in it for a scriber. The darning needles used are about four

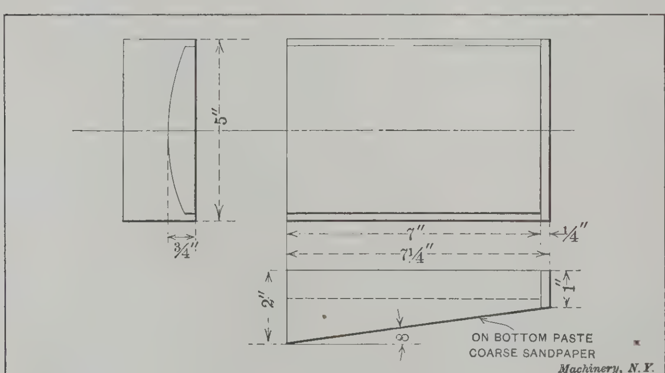


inches long and 0.040 inch in diameter. These needles cost five or six cents a dozen and they can easily be replaced when one is broken or dulled. I have shown this scriber to fellow tool-makers, and it is readily adopted wherever shown.

Passaic, N. J. L. ROSENTHAL.

DRAFTING TABLE PENCIL-HOLDER

The pencil holder shown in the illustration may be made of either wood, or aluminum. A very pretty effect is secured by making it of ½-inch strips of maple and cherry alternating. As an eight degree tilt is a convenient one for a table, this holder is made with the same angle so as to keep the



pencils from slipping out. By having sandpaper on the bottom, it can be used on a table that is considerably tilted by turning it around and having the cleat down. Most all draftsmen are subject to annoyances arising from having their pencils and pens scattered all over the table; this holder, as can readily be seen, will remedy that.

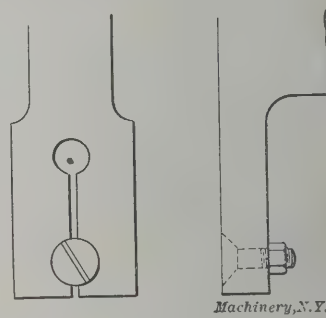
Three Rivers, Mich. E. G. PETERSON.

RESTORING OVER-EXPOSED BLUE-PRINTS

The average drafting office cannot keep a boy constantly making prints, and, consequently, when the boy is started tracing and intends to keep an eye on the printing frame, the print is often sadly neglected. Finding that in time this waste of paper was quite an expense item, we bought a quarter pound of potassium bi-chromate (a reddish crystal), dissolved it in a gallon of water, and placed the solution in a tray beside the wash tank. If a print is overexposed or "burned," it is first placed in this solution and then washed in clear water; in this way we seldom lose a print because of overexposure. It is, of course, possible to so burn a print that it cannot be bleached, but the ordinary burn of from two to ten times the required exposure, responds to the above treatment. The solution keeps indefinitely, if a few crystals and also water are occasionally added when required.

Rochester, N. Y. RALPH W. DAVIS.

ADJUSTABLE SLOT-FINISHING TOOL

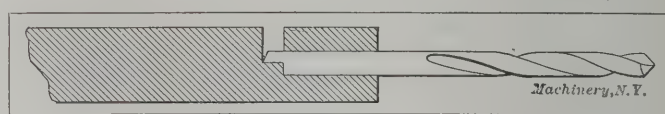


The accompanying engraving, which is self-explanatory, shows an adjustable slot-finishing tool for the planer. When much of this work is done, the dulling of the side edges will, in a few days, cause the tool to cut small, which, when the slots have to be exact, can be only remedied by forging. An adjustable finishing tool like this one will stay out of the blacksmith shop a dozen times as long as a solid tool.

Middletown, N. Y. DONALD A. HAMPSON.

AN EXTENSION DRILL

The accompanying illustration shows a way of making small extension drills, that may be new to some. In the extension rod a hole is first drilled which is a snug fit for the shank of the drill to be used. Then, after measuring the depth of this hole and marking it on the outside of the rod, a slot is filed at the farther side of the mark half way through the extension rod, so that it just meets the bottom of the hole. This slot should be approximately as wide as the diam-



eter of the drill. Next, the shank end of the drill is filed to the center for a distance equal to the width of the slot. After the drill is pressed into the extension rod as shown, it is ready for use. In this way an extension drill can be made much more quickly than by the old soldering method, and after using, it may be easily pulled apart without injury to the drill. CHESTER L. LUCAS.

East Saugus, Mass.

TO REMOVE BROKEN WOOD SCREWS AND NAILS

Perhaps nothing is more exasperating to the amateur wood worker than to have a wood screw break in hard wood just before it is screwed home, or to break off a nail where another nail must be driven. Such accidents are particularly provoking to a machinist. His experience on metal work is not of much assistance to him in overcoming such dilemmas, and to such the following kink is worth description. Secure a brass or steel tube slightly larger than the shank of the broken screw. File teeth in the end and give them the proper set, bending alternate teeth out and in. You thus are equipped with a hollow drill, which can be slightly squared at the other end to fit a carpenter's brace. With this tool the wood surrounding the broken screw can be trepanned out; the hole should then be filled with a plug of the same wood set in glue. After the glue has set a hole can be bored and a new screw can be put in, and no one will be the wiser.

M. E. CANEK.

* * *

The principal buildings, bridges, and other municipal structures of New York will be ablaze with lights during the Hudson-Fulton celebration. All bridges and principal buildings are outlined with rows of eight-candle power electric lights, and 1,500,000 lamps have been strung. The incandescent lights alone amount to 12,000,000 candle power, and will require about 42,000,000 watts or 56,000 horse-power. Beside the incandescent lamps there will be flaming arcs and other lamps of great power. The illumination will continue every night from September 25 to October 9 from 6:30 to 12:30.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

BATH DUPLEX INTERNAL GRINDING MACHINE

An improvement on the duplex internal grinding machine brought out by the Bath Grinder Co., of Fitchburg, Mass., which was mentioned in a note in the April, 1909, issue of MACHINERY, has recently been placed on the market. This improvement embodies a number of new and interesting features which are illustrated in the accompanying half-tones, Figs. 1 to 4 and in the line engraving Fig. 5. This machine is distinctly a new departure in internal grinding machines, and places internal grinding on as practical a basis as that which external grinding has achieved during the last decade.

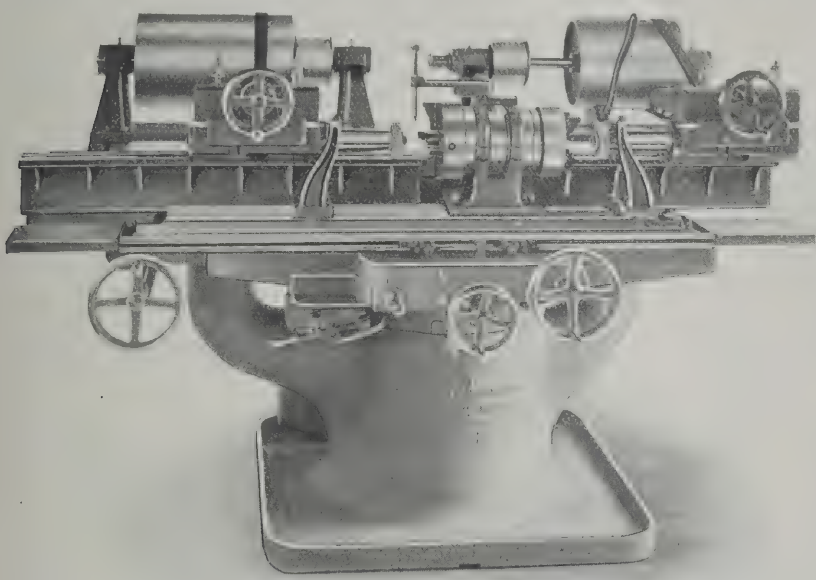


Fig. 1. Bath Duplex Internal Grinding Machine, having Two Wheel-spindle Heads

General Features

The principal advantage of the Bath duplex grinder is that the arrangement of the grinding spindles and the work-holding head or heads makes it possible to gain considerable time in the grinding and gaging of internal work; two pieces can be ground on the machines simultaneously, and it is not necessary to shift the reciprocating slide in order to gage, insert or remove the work. It is possible to use two grinding wheels at once, one operating from each end of the work. It is also possible to use a number of grinding wheels mounted on a supported spindle between the two grinding heads, and to quickly grind the inside of a sleeve or bushing by having one wheel after the other enter the work, the previous wheel, of course, leaving the work before the next one enters. This saves considerable time over the necessity of reversing the reciprocating table for each cut, as is necessary with grinding machines of the common type.

The novel feature which distinguishes this machine, in particular, from other designs, is that the grinding wheels and spindles pass in through the back end of the head-stock spindle as shown in Figs. 2 and 5, instead or running into the head-stock spindle from the front as in other grinders. Internal grinding has commonly been considered as a slow process when a large amount of stock has to be removed, but this objection is effectively overcome by the innovations in this design, and a considerable increase in production has thus been made possible.

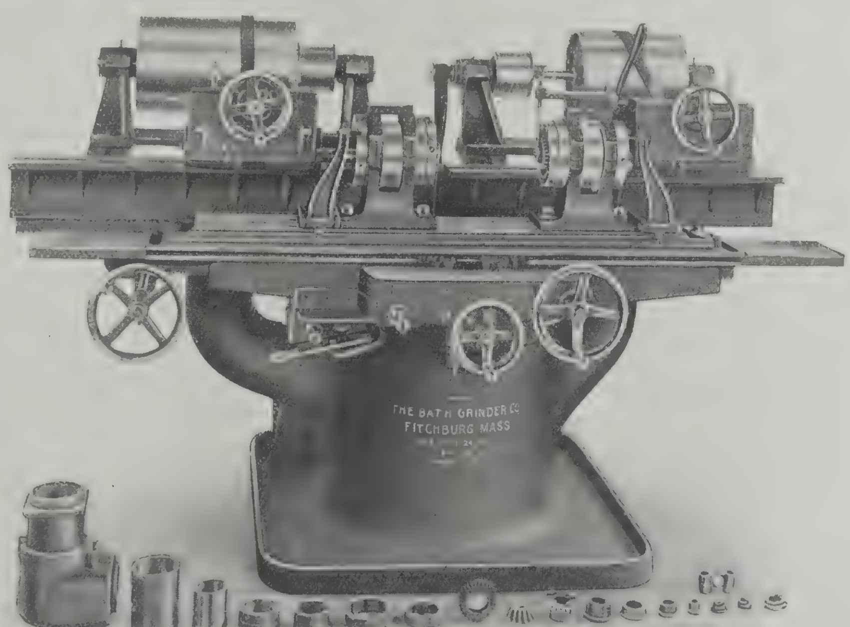


Fig. 2. Bath Internal Grinder Specially Equipped for Automobile Work

Fig. 1 shows the machine set up for grinding bushings held in four-jaw chucks, one chuck being mounted on each end of the head-stock, and the grinding heads, wheels, and wheel spindles being shown one on each side of the head-stock. In Fig. 2 the machine is shown especially fitted up for automobile work, and is set up for grinding the bores of spur gears. In front of the machine on the floor, a variety of work that has been ground on this machine is illustrated.

The spur gear standing on its face in front of the machine is one of the pieces being ground at the moment in the machine. In this case, two head-stocks are mounted on the table, the spindles of these head-stocks being 8 inches in diameter. The object of the large head-stock spindle is to make it possible to grind large work, up to 6 inches in diameter, by holding it inside of the chuck spindle, thereby absorbing and eliminating the vibration and the twisting stresses when the wheel is brought against the work.

In front of the machine to the left of the hand-wheels is shown the reverse lever. This lever, by being turned one-quarter of a revolution, automatically stops the machine at the end of its stroke, and also reverses the reciprocating slide. The operator does not need to wait to operate the lever until the slide reaches the end of the stroke, but can turn the knob at any time during the stroke at the end of which it is wanted to stop the machine automatically. When the machine is stopped, the end of the work in one of the head-stocks is exposed to view, and is in position to be gaged instantly. To gage the work held in the opposite head-stock, the reverse lever is pushed over, which brings the other head in position to gage. The general relation of work and spindles is plainly shown in Fig. 5. The distance between the two head-stocks is sufficient so that when one of the spindles is in the position shown with the wheel to the right just projecting through the work and head-stock, the work in the other head-stock can be easily removed and a new piece of work mounted in position for operation. It will be also noticed that considerable time is saved by this construction when gaging the work, as it is not necessary to move the reciprocating slide away from the head-stock in order to measure the size, as is

required in internal grinding machines of general design; the time consumed in measuring two pieces of work is practically no more than that required for measuring one in a single-spindle machine.

Head-stock and Spindle Heads

The head-stock spindles are driven directly from a drum counter-shaft, the same as in ordinary grinding machines, the only difference being that one belt is, of course, required for each head-stock. The grinding-wheel spindles are driven by a belt from drums provided directly on the machine as shown, the shafts on which these drums are mounted being provided with small pulleys driven directly from the counter-shaft. Thus the complete machine is driven by a two-piece counter-shaft, one for furnishing the power for the wheel-spindles and one for the head-stocks, in a manner similar to that of the ordinary type of grinders.

Fig. 3. Assembled and Dismounted Head-stock and Parts

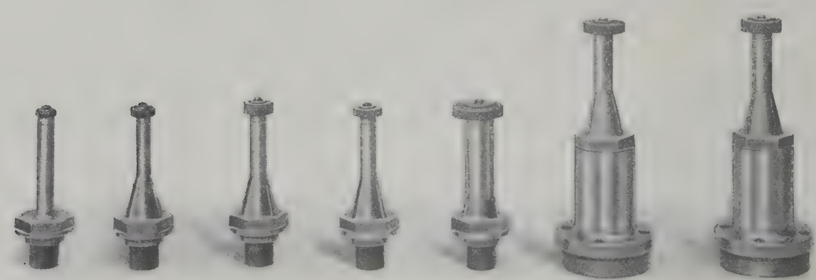


Fig. 4. A Set of Grinding Spindle Extensions for the Duplex Grinder

Each of the grinding-spindle heads is provided with an automatic sizing feed so that the wheels can be fed up to the work independently of one another. The automatic feeds are operated by hinged arms which come in contact with the ends of square rods on the head-stock, thus causing the automatic feed to be operated the same as the power automatic feed on grinders in general. Each spindle-head has a sizing device so that each slide can be set to remove a predetermined amount of stock, and when the required size has been reached the automatic throw-out arrangement disengages the feed. An adjustment is also provided for the variation in the diameter of the wheels.

The spindle-heads are carried on two long narrow slides instead of as formerly on one wide slide. On account of this construction the wheel-head is much more rigidly mounted and the deflection commonly met, due to the pressure of the grinding wheel, is largely eliminated. The narrow slides on which the spindle-heads are carried are mounted on a beam so that the spindle-heads can be placed in position longitudinally instead of moving the head-stock or vice versa.

In Fig. 3 are shown the two head-stocks shown in Fig. 2 with one of the head-stocks disassembled to show the method of holding the spring chucks. The four-jawed chuck is mounted in the same manner. At the outer end of the spring chuck there are four hardened steel jaws, which are detachable and which can be changed according to the diameter or size of work; special chuck jaws may also be furnished for holding either bevel or spur gears on the pitch line. The jaws are ground on the machine so that they are absolutely true with the spindle. The head-stocks shown in the illustrations are for straight work only, but swivel head-stocks of the type shown in Fig. 5 are furnished if required, so that straight or taper work can be ground, the tapers being set at any angle required. As the heads are entirely independent of one another, a straight hole can be ground in one head while a taper hole is being ground in the other. A traveling diamond is mounted on the top of the head-stock for truing the wheel whenever necessary.

The reciprocating slide is run at a speed of from 2 to 12 feet per minute. It has five changes of speed and is operated by a gear box underneath the cross-slide on the left-hand side, as shown in Figs. 1 and 2, and is controlled by a single lever.

Grinding Spindles

In Fig. 4 is shown a set of seven grinding spindles. The set of two spindles at the right, shown mounted on the extension arbor, are the two spindles shown in use in Fig. 2. The other spindles complete a special set furnished for automobile work, having lengths and diameters to suit the work to be ground. The extension arbor is attached to the wheel-head by fillister-head screws. Into this extension is threaded the secondary extension provided with a hexagon head on its end. This extension contains the bearings for the spindle proper, which revolves inside and which is driven from the main spindle by means of a projecting key or tongue on the end, engaging

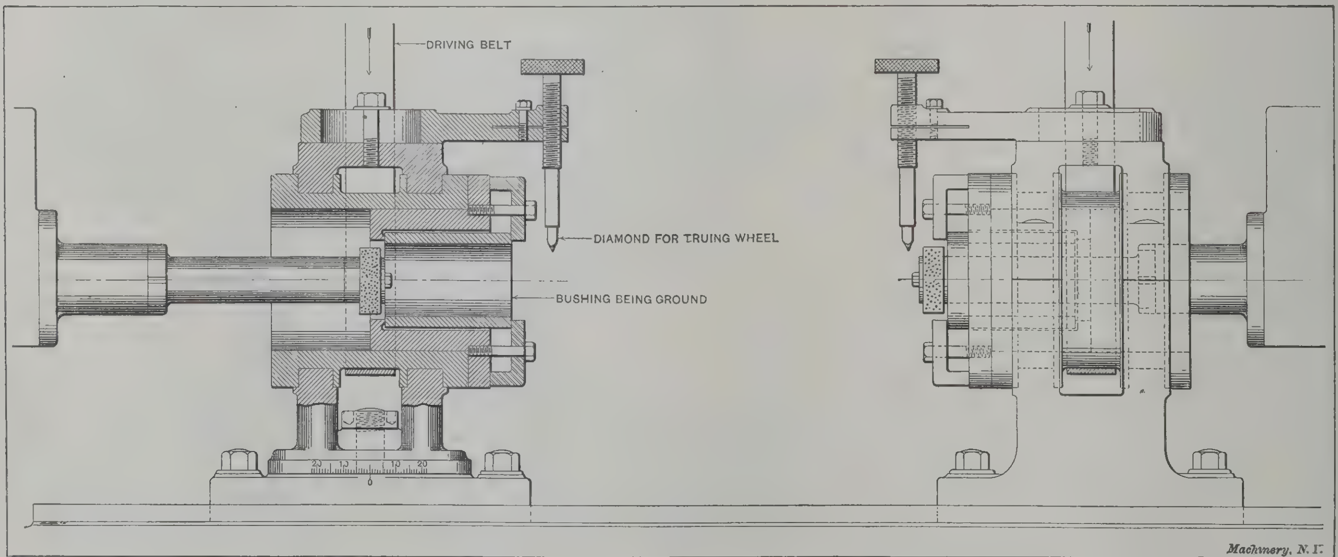


Fig. 5. Section and Elevation of Head-stocks and Work and Relation of Head-stocks to the Grinding Wheels

into a square slot in the end of the main spindle. The hexagon head on the secondary extension is a feature which was provided for special reasons. In changing these spindles, the operator of the machine many times loses the spanner wrenches, and to avoid inconvenience, a monkey-wrench can be used which at the same time assures that the spindle will be tightened up firmly.

The machine is also furnished with a supported spindle that can be mounted at each end in the spindle-heads and on which can be mounted from one to six grinding wheels. For example, in grinding a bushing 2 inches long, the wheels would be spaced apart the length of the bushing, and all six could pass through the bushing before being reversed. Another method that can be advantageously used is to hold the work to be ground in the spring collet and use the two single-ended grinding wheels brought up together and grinding at the same time, removing the stock within 0.001 or 0.002 inch of size. After this is done, one of the wheels can be stopped and the hole finish ground with a single wheel. Still another method advantageously used on this grinder is to employ a coarse wheel on the one head for roughing and a fine wheel on the other head for finishing the same piece of work. Parts like those for pneumatic hammers which have four bearings to be ground concentric with each other can be ground without reversing the work when once mounted, and the work can be gaged from either end of the chuck.

The amount of power consumed by the grinder is 2.7 H. P. By means of a brake provided, it is possible to stop the machine in four seconds with the belts at full speed. The machine in general has been rigidly designed so that it is possible to use larger and wider wheels and remove a larger amount of stock than with former designs.

Some examples of the capacity of the machine may be interesting. Some manganese car wheels having a bore of 3⅛-inch, 6 inches long, were ground in 55 minutes each, removing 5/32 inch of stock with a single spindle from a rough-cored hole. A 15/16-inch hole, 1¾ inch long, can be ground in two minutes with a single spindle removing from 0.006 to 0.008 inch of stock.

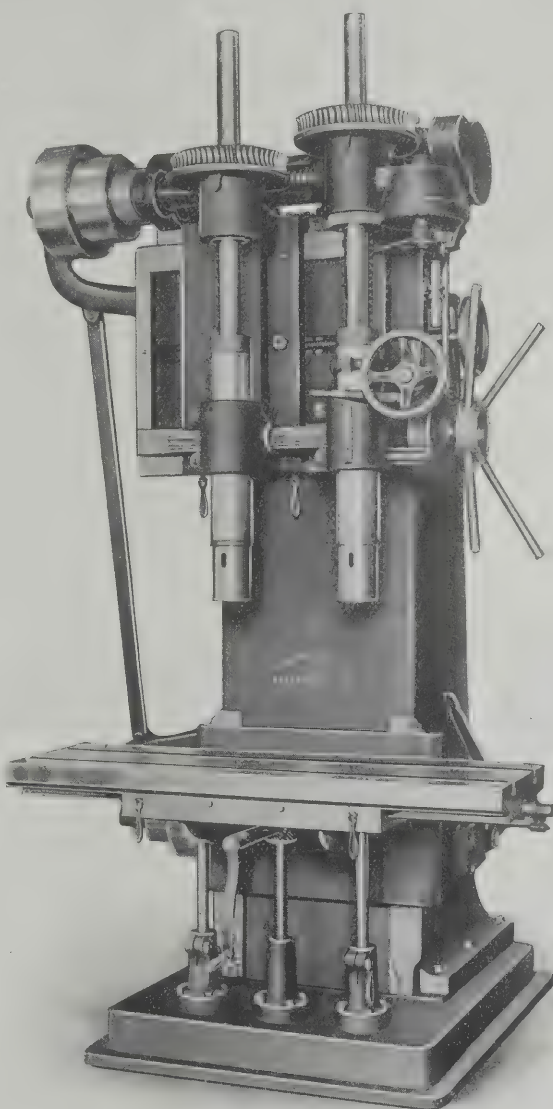
HOEFER VERTICAL TWO-SPINDLE CYLINDER BORING MACHINE

Considerable attention has been given by the Hoefer Manufacturing Co., Freeport, Ill., to the requirements of automobile manufacturers for a satisfactory cylinder boring machine. Such a machine must be able to finish the work both rapidly and accurately, and in order to accomplish these two objects the company has designed a very heavy two-spindle vertical automobile engine cylinder boring machine, an illustration of which is shown in the accompanying engraving.

The two heavy spindle heads are gibbed to a short stiff cross-rail. The right-hand spindle is solidly bolted to the rail and doweled with taper pins, while the left-hand spindle is adjustable by means of a screw operated by a hand-wheel, this adjustment providing for the variations in center distances in different sizes of engines. Tapered holes are provided in the adjustable head so that when jigs have been made for various sizes of engines, these holes can be drilled through into the cross-rail and pins inserted, thus providing positive stops for each size of engine cylinders, and a saving of time in locating the heads for each side.

The bearing of the spindle sleeve is slotted so as to provide for wear. The spindles themselves are made of high-grade crucible spindle steel, chosen with particular regard to its toughness, and are accurately ground so as to minimize the wear and insure the maintenance of accuracy, and are provided with No. 5 Morse taper sockets. The spindle sleeves are bushed with interchangeable phosphor bronze bearings, which can easily be replaced. The thrust bearings are also made of phosphor bronze. The spindles are driven through a pair of large double-threaded worms meshing with phosphor bronze worm-gears, the studs of which are ground and run in copper-hardened babbitt bearings. A substantial key in the driving worm-gear engages in a keyway in the spindle and insures that the drive is ample for any work within the range of the machine. The worms are encased in an oil pan provided with a felt oiler, thus securing sufficient lubrication. An oil pan is also placed under each worm-gear to return any oil to the worm oiling cases. The final drive is obtained through spur gearing and by means of a three-step cone pulley having wide steps for a belt of sufficient size.

A positive gear feed similar to that furnished with the company's regular line of drills is provided. This feed is driven directly from the main spindle, four changes are provided, and the entire gearing mechanism is encased in a feed gear box. The vertical worm is thrown into engagement with the phosphor bronze gear encased in the worm-wheel shell, by means of a small lever directly in front of the operator, and an adjustable automatic stop is provided for the disengagement of the power feed at any predetermined point. A long cross-spindle with teeth cut the entire length drives both spindles uniformly.



Two-spindle Vertical Automobile Engine Cylinder Boring Machine, built by the Hoefer Mfg Co., Freeport, Ill.

The table is made exceptionally deep vertically, to give it the necessary stiffness, and prevent springing when jigs are clamped to it. The bearings in the saddle are large, and proper provision is made for lubrication, the oil holes being in the front of the machine for convenience in oiling. The traverse of the table is obtained by means of a coarse lead-screw or by a rack and pinion, according to the requirements of customers. The table is gibbed to a rigid knee, which besides having ample vertical depth, is also provided with two supports in addition to the elevating screws. The bearings are wide both in the saddle and on the column, and stout ribs resist the twisting strains brought to bear upon the knee when the table is heavily loaded and at the end of the travel.

The method of operating the machine is very rapid and simple. Four units of two cylinders each can be placed in a properly designed jig, and cylinders Nos. 1 and 3, for instance,

are bored simultaneously. Then the table is moved over and cylinders Nos. 2 and 4 are bored. While the process of boring these cylinders takes place, cylinders 5, 6, 7 and 8 are placed in position in the jig. As soon as the work is completed on the first set of two units, the table is set over so that cylinders Nos. 5 and 7 can be bored, and then Nos. 6 and 8. Meanwhile new cylinders are placed in the jig on the opposite end of the table. Thus a practically continuous process of boring is made possible. The method, as described, insures great accuracy in the alignment of the bores.

The total height of the machine from the floor to the top of the column is 110 inches, and the maximum distance from spindle to table 39 inches. The maximum distance from center to center of the spindles is 19 inches, and the minimum 9½ inches, the distance from the column to the center of the spindle being 12½ inches. The vertical feed of the spindle is 19 inches, and the feeds per revolution of spindle are 0.062, 0.125, 0.187 and 0.250 inch. The size of the table is 18 x 56 inches, and the floor space 52 x 58 inches. The net weight of the machine is 8,000 pounds.

THE COIT TWENTIETH-CENTURY BALL-BEARING DRILL CHUCK

The drill chuck shown herewith is made by the Standard Machinery Co., Mystic, Conn. As may be surmised from a study of the parts, shown disassembled in Fig. 2, it is of the type in which the jaws are tightened on the drill by the resistance required to drive it. There is thus no possibility of its slipping, as the drive is proportioned to the work required of it.

The chuck consists, as may be seen, of a taper shank or mandrel (forming an integral part of the tool), a knurled shell or jaw holder free to revolve on the mandrel against a

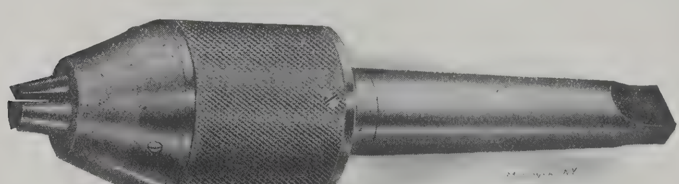


Fig. 1. Coit's Ball-bearing Drill Chuck, made by the Standard Machinery Co., Mystic, Conn.

ball thrust bearing, a collar provided with slots for the heads of the jaws, and the jaws themselves. The parts, it will be seen, are few, simple and of strong design. In operation, the turning of the knurled sleeve of the assembled chuck with its jaws, rotates also, on the threaded mandrel, the collar in which the heads of the jaws are contained. As the collar is thus screwed in or out on the mandrel, the jaws are screwed in or out of the chuck, and thus released or tightened on the work.

The use of a right-hand thread on the shank makes the chuck self-tightening for a right-hand drill. If the drill is barely caught in the jaws, the moment it strikes the work, resistance to turning is offered, and the rotation of the whole chuck sleeve and jaw is arrested. This screws the collar out on the mandrel, pushes the jaws forward, and thus tightens the grip. Any increase of resistance, accompanied by a corresponding slippage of the sleeve, is met by an immediate strengthening of the hold.

In spite of this positive drive, the operator can release the drill with a gentle twist on the knurled sleeve. This easy release is made possible by two things: first, the use of the ball thrust bearing; and second, the small diameter of the thread by which the adjustment is effected. This small diameter reduces the friction, and thus prevents jamming the chuck, no matter how strong the drive. It is, in fact, the practice of the workmen, in using this chuck, to insert and remove drills while the spindle is running, at all except the highest speeds.

Attention should be called to a number of points in the general design of the chuck. The end of the mandrel has a bearing in the sleeve, making a stiff unyielding journal for the turning of the one on the other. The jaws seal the only possible entrance for grit and chips into the interior, which is thus protected from injury and wear. One application of oil will last almost indefinitely. The mandrel is a part of the chuck, and is sold as such, so the expense of making it is saved. It will be furnished with any suitable taper, or with a straight shank. The separate jaws can be removed or inserted without taking the chuck apart.

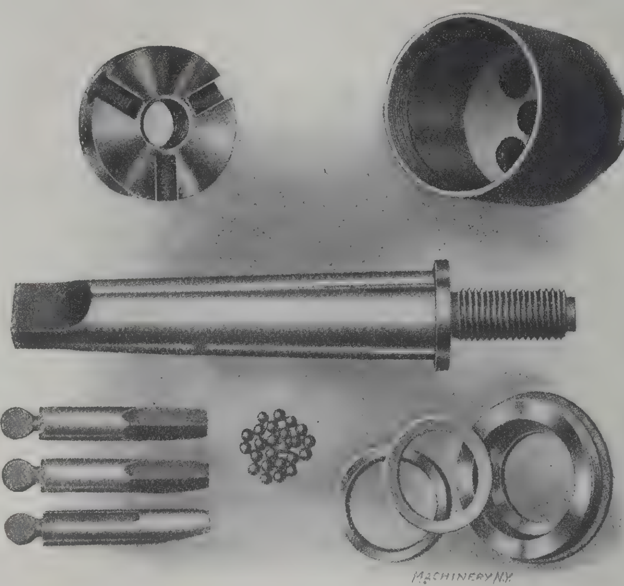


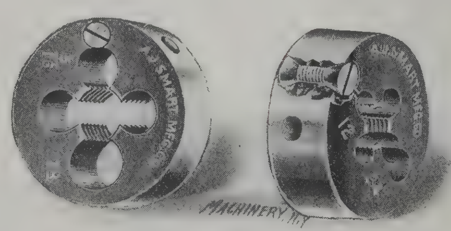
Fig. 2. Chuck Disassembled, showing Parts and Simplicity of Construction

Perhaps the most valuable feature of a tool of this kind is the saving of the drills. Since there is no slip, the shanks are protected from marring and stripping, and their useful life is greatly lengthened. It is possible to drill to a reasonable depth also with an old, short drill, as a very short drive in the chuck jaws does as well as a longer one.

These tools are made with great care, to judge from what can be seen on a visit to the factory. Special pains are taken to make them accurate and interchangeable. Five sizes comprise the complete line, ranging as follows: No. 1, 0 to 13/64 inch; No. 2, 0 to 21/64 inch; No. 3, 0 to 17/32 inch; No. 4, 1/16 to 3/4 inch; and No. 5, 5/16 to 1 inch.

SMART ROUND ADJUSTABLE DIE

The accompanying engraving shows the design of a line of improved round adjustable dies made by the A. J. Smart Mfg. Co., Greenfield, Mass. The dies are sawed through on one side as usual, while the opposite side is drilled out and spring tempered, leaving but a small portion of the metal. As seen from the illustration, the adjustment of this die consists of a taper-headed screw, provided with the required de-



Round Adjustable Die of Improved Design, made by the A. J. Smart Mfg. Co., Greenfield, Mass.

gree of taper to insure a quick and positive adjustment. This screw enters into a cone-shaped nut of the same taper as the head of the screw. When the screw is turned to the left, the head will rise relatively to the nut and the spring temper causes the die to close, thus making it cut a smaller size. By turning the adjusting screw to the right, the screw enters further into the nut, and on account of its taper head, it spreads the die open so that it will cut a larger size. One of the principal advantages of this die is that it can be adjusted from the face without being removed from the holder in which it is used. These dies are made with 13/16, 1, 1 15/32, 1 1/2 and 2-inch outside diameters.

NEWTON TWO-SPINDLE LOCOMOTIVE FRAME DRILLING MACHINE

The accompanying half-tones, Figs. 1 and 2, illustrate a new design of two-spindle drilling machine recently brought out by the Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine has been designed with the object in view of giving it sufficient range and flexibility of operation for work on parts for all sizes and types of locomotives, and is, in addition, particularly adapted for drilling the holes in locomotive frames.

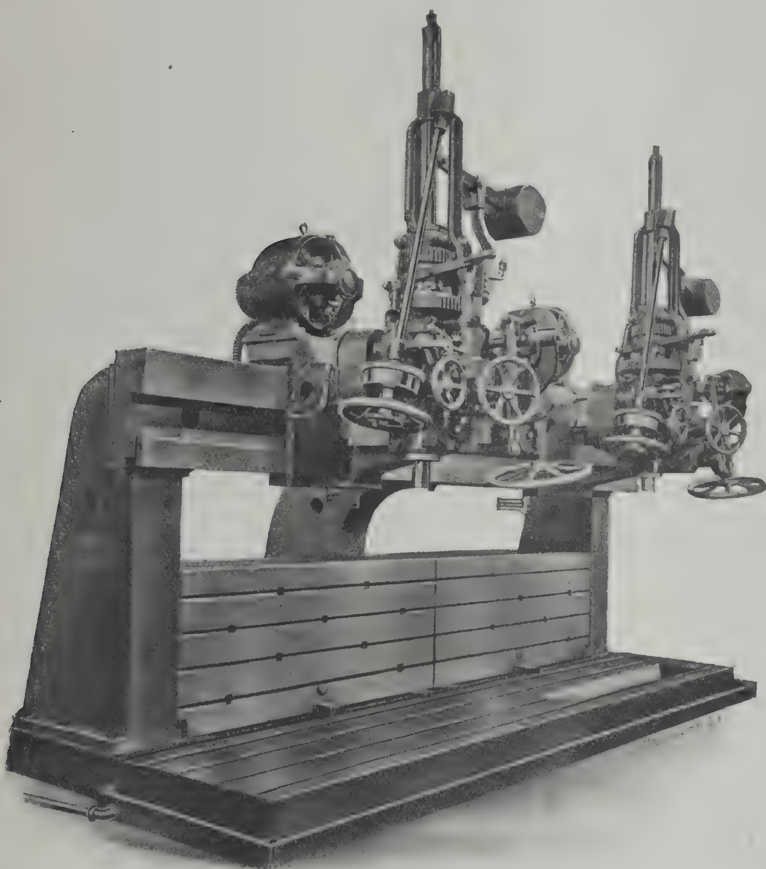


Fig. 1. Front View of Newton Two-spindle Locomotive Frame Drilling Machine

The spindles of the two drilling heads are 4 inches in diameter, and have an automatic geared feed of 18 inches, and a vertical adjustment of the same amount through direct connected gearing for the fast hand traverse, and through a worm and worm-wheel operated through a friction clutch for the slow hand adjustment. The range of the spindle speeds is from 28 to 456 revolutions per minute, and four changes of feed are obtainable, being, respectively, 0.0078, 0.0126, 0.0156, and 0.0225 inch per revolution of spindle. The spindle sleeves have a length over-all of 48 inches. The lower part of the sleeve bearing is in the head or saddle proper for a length of approximately 28 inches; this eliminates all unnecessary overhang. The spindle sleeve revolves in brass bushed bearings of ample dimensions, and the top of the sleeve is supported in brass bushed bearings in the rack sleeve yoke.

A departure from the common design of the driving mechanism lies in the fact that the spindle sleeve carries the clutch gears by which it is driven, and also the clutch for their engagement. The spindle is counter-weighted and is provided with a roller thrust bearing at the bottom of the rack sleeve. It is provided with a taper hole to take No. 5 Morse taper shank. Fast reversing traverse is provided for the saddle on the cross-rail by means of a double train of bevel gears and a clutch. A horizontal adjustment of the saddle is obtained by hand by means of the hand-wheels shown at the bottom of the arms in Fig. 1. The minimum distance between the centers of the two spindles is 4 feet, and the maximum distance 15 feet.

The spindles are driven by individual 10 horse-power electric variable speed motors, the speed variation being from 300 to 1,200 revolutions per minute. The motion is transmitted from the motor shaft to the horizontal driving shaft by spur gears. On the driving shaft is mounted a double train of bevel gears, and from here the power is transmitted to the vertical shaft on which the spur back-gears are mounted, giving two changes of speed in addition to the range of speed changes of the motor. The bracket on which the motor is mounted is cast solid with the arm, this giving a very rigid construction, which is, in particular, required when subjecting the machine to the heavy strains occurring when using high-speed steel drills.

As will be seen in Fig. 1, the gears controlling the feed mechanism are mounted in a gear box, the different combinations being engaged by a key controlled by a small hand lever, as shown. Lateral hand adjustment is provided for the spindle saddle on the arm, the range being from a minimum distance of 6 inches to a maximum distance of 24 inches from the face of the cross-rail to the center of the spindle. The arm has two bearings on the top of the cross-rail, these being removable for renewals and provided with brass taper shoes to compensate for wear. The cross-rail is of the box type construction and is of very heavy ribbed section.

The machine is furnished with two adjustable tables for holding the work, each being 30 inches wide by 36 inches high by 7 feet 6 inches long. These tables are of box type construction, having vertical and horizontal working surfaces provided with large T-slots for clamping the work. The machine is also provided with a floor plate, the front part of which is provided with T-slots and which provides for a work table 39 inches wide by 17½ feet long. This work table is entirely surrounded by an oil pan for receiving the lubricant. The bed plate also supports the three heavy uprights which hold the cross-rail. The upright in the center is of special construction in order to permit the two adjustable work tables to be adjusted or moved entirely out of the way, when the lower table is used, as shown in Fig. 1. In Fig. 2 are

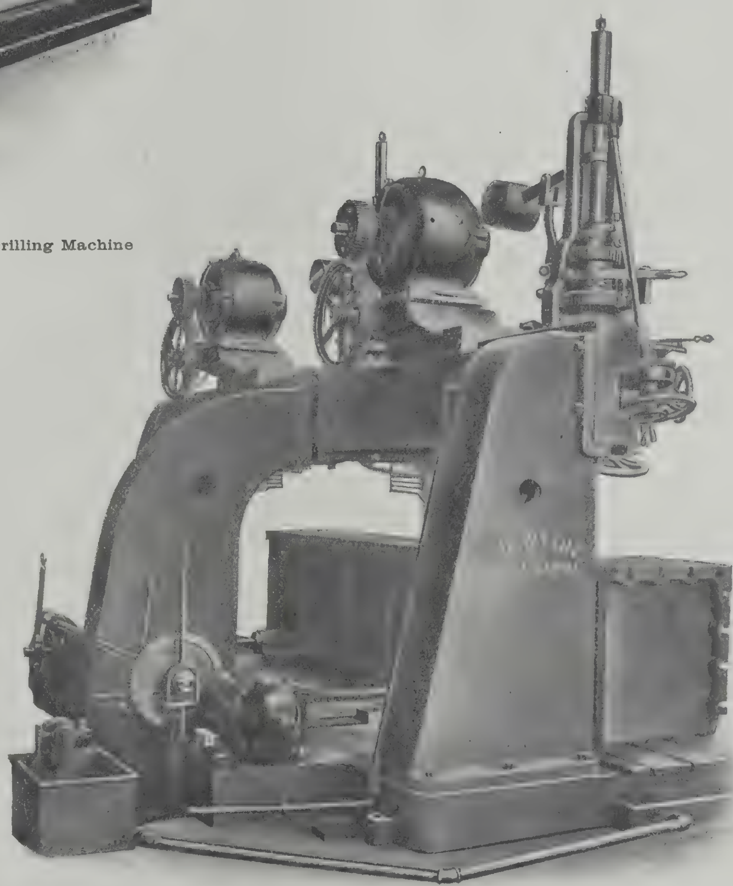


Fig. 2. Rear View of Newton Two-spindle Drilling Machine, showing Motor which operates the Adjustable Work Tables

shown the coarse-pitch screws provided for adjusting the work tables. The motion for this is transmitted through individual worms and worm-wheels from a five horse-power General Electric motor. This design permits of either simultaneous or independent power adjustment of the work tables. A pump, piping, and oil tank are also provided with the machine, as shown in Fig. 2. All bearings on the machine are bronzed bushed, and all gears are made either of steel or bronze.

The drilling mechanism is of the same general design as that provided for the radial drilling machines made by the Newton Machine Tool Works, with which it is possible to drill three-inch diameter holes at the rate of three inches per minute when using a flat twisted drill. Smaller diameter drills can be driven at a much higher rate of speed, in proportion. The maximum distance from the floor plate to the end of the spindle is 81 inches and the minimum distance 64 inches. The machine occupies a floor space of about 19 by 20 feet.

NOS. 3 AND 3A CINCINNATI AUTOMATIC GEAR-CUTTING MACHINES

In the May, 1908, issue of MACHINERY, we described an automatic gear-cutting machine built by the Cincinnati Shaper Co., Cincinnati, O. The making of this machine has since been transferred to the Cincinnati Gear-Cutting Machine Co., of the same city, which has brought out the smaller-sized

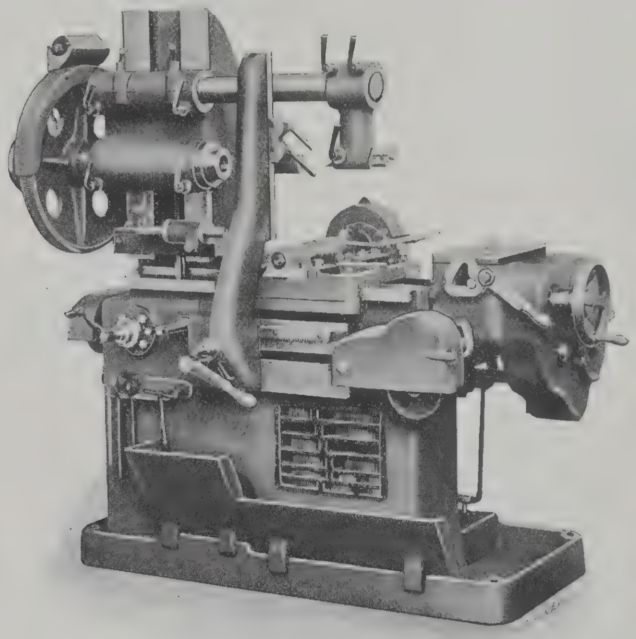


Fig. 1. A New Cincinnati Gear-cutting Machine, of a size well adapted to Automobile Work

tool illustrated herewith. This is made in two heights of column, giving maximum diameters of 26 inches and 36 inches respectively, for gears having any width of face up to 10 inches. It will be seen to be particularly adapted in its dimensions to automobile work, as well as to the general run of small and medium machine work.

The main features of the original design are retained. The machines are noticeable for their strength and simplicity. In the matter of rigidity attention is called to the carrying of the ways for the cutter slide beyond the column, and to the locating of the spindle bearing in the middle of the cutter slide. Fig. 3 shows the cutter slide turned bottom up, and gives a good idea of the construction of the full length taper gibs used. The principle of broad bearing surfaces with grinding surfaces located near together, is employed. The same principle applied to the work saddle prevents it from dropping out of parallelism when the clamps are loosened, to adjust the work to the required depth of cut. This adjustment is effected from the front of the machine, and is provided with a graduated index reading to one-thousandth of an inch.

The dogs for controlling the movement of the feed-slide are adjusted from the front of the machine, being mounted on threaded rods at the rear, connected by bevel gearing with crank-shafts at the front. A retractable tappet for these dogs is provided, so that the slides can be run to the extreme back position, for removing blanks without disturbing the setting of the dogs. There are twelve changes of feed. The cutter slide is fed forward and retracted by a screw, controlled by

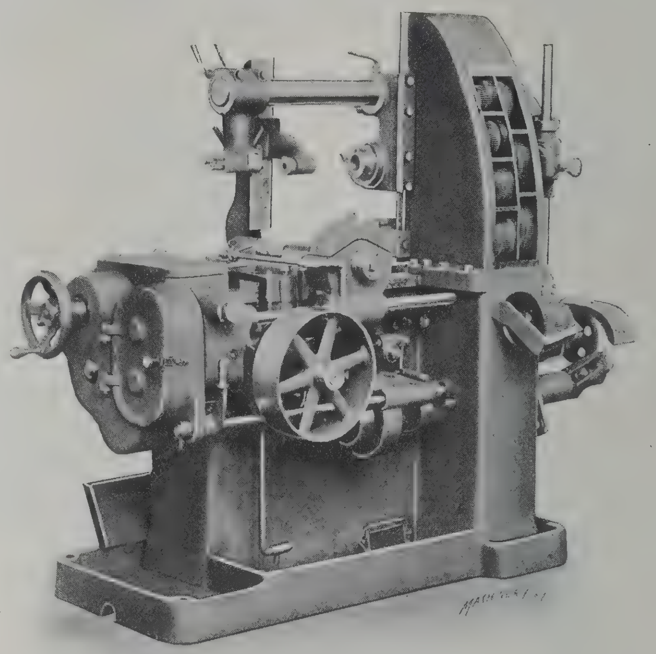


Fig. 2. Rear View of No. 3 Machine, showing Driving Connections

a reversing mechanism which gives a constant return speed, regardless of the feed. Twelve changes of feed are provided.

The cutter spindle shown mounted in its bearing in Fig. 5 is of large diameter, accurately ground and easily accessible for taking up wear. It is mounted in both taper and straight bronze bearings, and is adjustable endwise for centering the

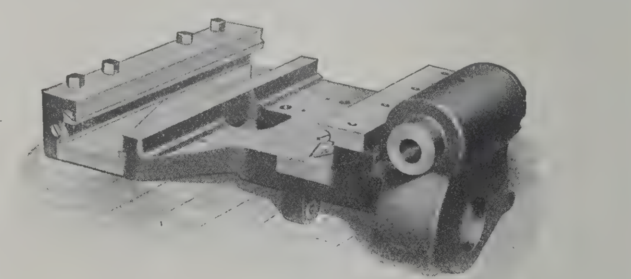


Fig. 3. Cutter Slide Reversed, to show Gibs and Bearing Surfaces

cutter. The drive, as shown, is through a worm and wheel, with means provided for taking up the end thrust of the worm. A removable outboard bearing for the cutter arbor is provided, the latter being drawn into place in the spindle or forced out by a threaded bolt. Six cutter speeds are provided.

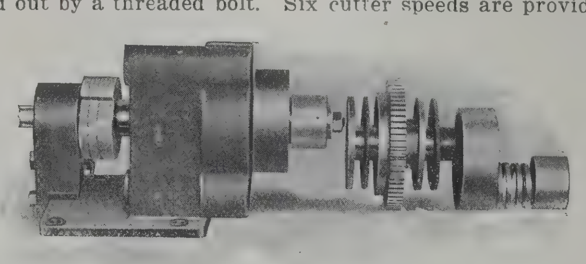


Fig. 4. Friction Stop Mechanism for Indexing; shown Assembled and Dismantled

The indexing mechanism is of unusually simple construction, there being fewer gears in the index train than on any other machine of this type. The motion is transmitted and controlled through a friction operated stop disk, simple and easily accessible. This mechanism is shown in Fig. 4. A spanner wrench is the only tool necessary for adjustment. The index worm can be disengaged from the wheel quickly,

and brought back into the exact meshing depth; or it can be disengaged from the index gears and rotated any desired amount for resetting work, after which it may be again secured. Besides provision for automatic indexing, it may be made to space once or revolve continuously, by a hand movement under the control of the operator. The mechanism is so interlocked with the cutter slide feed that the various movements must of necessity take place in proper sequence, thus making it impossible to spoil work from failure of the mechanism. The change gears furnished cut all teeth from 12 to 100, and all numbers from 100 to 450, with the exception of prime numbers and their multiples.

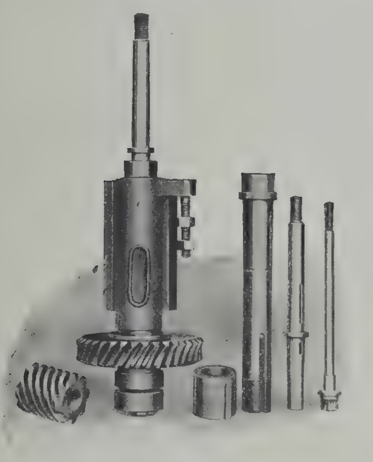
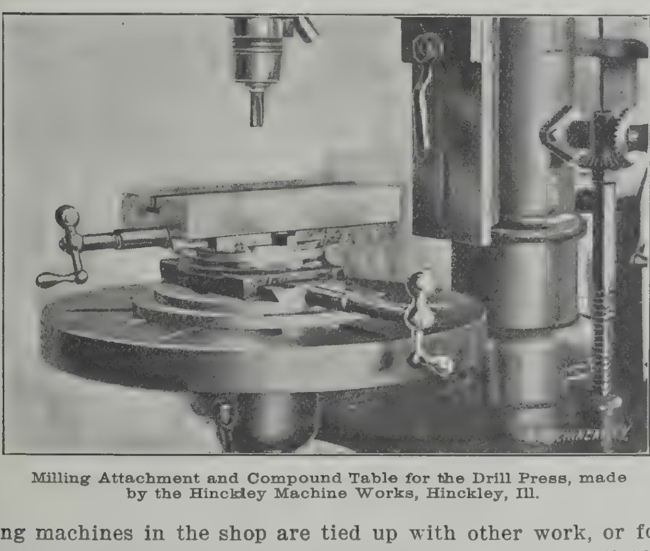


Fig. 5. The Cutter Spindle, its Worm-gear Drive and Axial Adjustment

As may be seen, the work arbor is provided with an over-arm work support, in addition to the regular outboard support. The machine is regularly equipped with a counter-shaft, though if desired it will be furnished with tight and loose pulleys mounted on the initial driving shaft. It can also be arranged for motor drive if desired. This is a very simple matter as all the changes of feed and speed are effected by convenient transposing gears.

DAVIS MILLING ATTACHMENT AND COMPOUND TABLE FOR THE DRILL PRESS

The accompanying illustration shows a useful attachment manufactured by the Hinckley Machine Works, Hinckley, Ill., and known as the Davis milling attachment and compound table for the drill press. This device has been designed with a view to furnishing an attachment for the drill press table which enables milling work, particularly end milling, to be done in the drill press advantageously, when the regular milling machines in the shop are tied up with other work, or for use in cases where a regular milling machine is not available.



Milling Attachment and Compound Table for the Drill Press, made by the Hinckley Machine Works, Hinckley, Ill.

The device is simple in its construction and consists of a circular base which is clamped down onto the drill press table. This base is provided with a dove-tail cross-slide for the saddle, which, in turn, carries a swivel slide, the top of which is provided with a dove-tail into which fits the slide of the table proper. Both the saddle and the table are provided with hand feed adjusting screws having ball-crank handles. The swivel slide is graduated in degrees and can be set to any angle. The table is provided with a ½-inch T-slot longitudinally, as shown in the engraving.

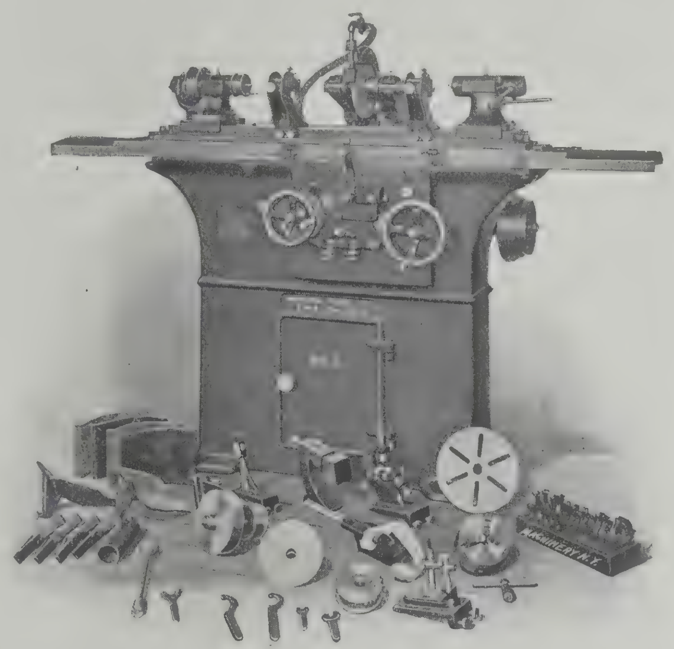
This device should prove a handy attachment for both large and small shops, and in repair shops where a regular milling machine is not available, in automobile garages, etc., it will prove of especial advantage on account of the simple and inexpensive substitute it provides for a regular milling machine.

MODERN UNIVERSAL GRINDER

The accompanying half-tone shows a universal grinding machine built by the Modern Tool Co., Erie, Pa., and designed with a view of placing on the market a heavy and rigid grinder with ample metal for absorbing the vibrations and preventing the ways from springing out of line.

The head- and foot-stock of this grinder are gibbed to the sides of the swivel table, this construction permitting of very large wearing surfaces, and making it possible to compensate for any wear which might occur on the head- or foot-stock. The head-stock is designed to swivel and is provided with a graduated base. The head-stock spindle is hardened, ground and lapped, and runs in phosphor-bronze bearings with means for taking up the wear. The end of the spindle is threaded and has a standard taper hole. Universal rests of new design, of great advantage when grinding long slender work, are furnished with the machine.

The driving and reversing mechanism is completely contained in and supported by a bracket bolted to the outside of the machine thus being easily accessible for oiling. If it becomes necessary to take off the bracket, it can be removed by unscrewing four bolts, and the entire mechanism can then be taken to a bench for cleaning or repairs. The wheel spindle is made of tool steel, is hardened, ground and lapped, and runs in phosphor-bronze bearings provided with means for taking up the wear the same as the head-stock spindle.



No. 2 Universal Grinder, built by the Modern Tool Co., Erie, Pa.

The table travels automatically, as usual, and is reversed in the common manner, by dogs. The power to the table is transmitted by worm gearing imparting a steady movement, free from jars. The reverse lever is so arranged that the table can be run past the point of reverse without disturbing the adjustment of the table dogs. An automatic cross feed is provided which gives a range of feed from 0.00025 to 0.004 of an inch. The feed can be thrown out automatically when the work has been ground to size. A simple attachment is also provided for fine hand feeds. There is no removable front plate, and the machine is so designed that the mechanism inside the grinder can be removed and replaced if required, without disturbing the alignment of the ways. A diamond tool holder is furnished for truing the wheel.

The machine is made in two sizes, Nos. 2 and 3, respectively. The No. 2 machine swings 9 inches in diameter and takes 26 inches between centers. The table is graduated up to 3½ degrees and 1½ inch taper per foot. This machine takes emery wheels up to 9 inches in diameter and ⅝ inch face. The

weight of the machine is 2,300 pounds, and the floor space required 36 x 94 inches. The No. 3 machine swings 13 inches in diameter and takes 32 inches between centers. The table is graduated up to 5 degrees and 2-inch taper per foot. This machine will take emery wheels 12 inches in diameter, ¾-inch face, and 9 inches in diameter, ½-inch face. The weight of the machine is 4,000 pounds and the floor space required 50 × 125 inches.

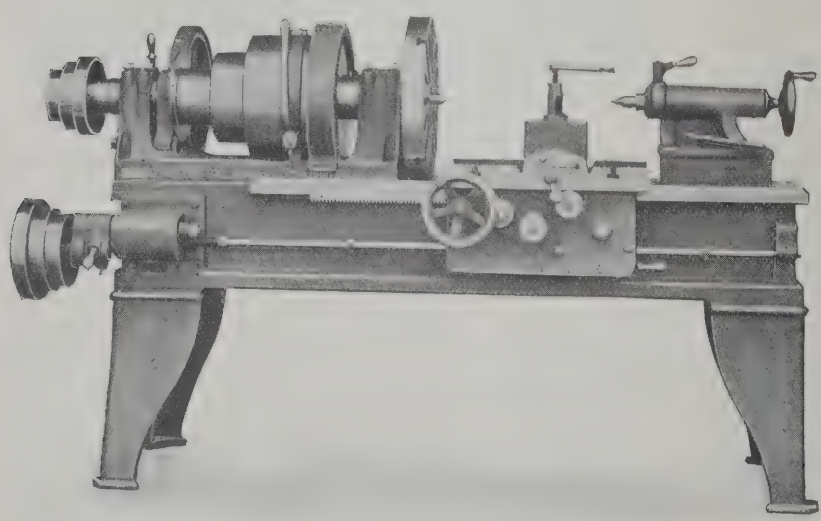
CHAMPION 18-INCH FRICTION BACK-GEARED MANUFACTURING LATHE

The heavy 18-inch lathe shown herewith was built by the Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, O., to meet the requirements of the large automobile manufacturers. As may be seen, both drive and feed are belt operated, and the mechanism has been reduced to few but strong parts. No lead-screw for threading is needed or provided. The design has been found particularly successful in heavy manufacturing, requiring rapid reductions.

The spindle is driven by a three-step cone, whose large diameter is 14 inches for a 4-inch belt. The back gears are friction operated, the clutches being of the expansion ring type, operated by a toggle mechanism controlled by the lever shown at the front of the head-stock. This provision allows heavy roughing cuts to be taken at a slow speed, while a reversal of the lever gives the change to high speed for the finishing cut, without stopping the machine. The back gear ratio is 12 to 1. A 1⅝-inch hole is provided through the spindle.

The feed cones carry a 1½-inch belt. The lower cone is journalled in a swinging frame for tightening the belt, being clamped in position by a screw shown on the under side. An automatic throw-out clutch is provided on the feed rod inside the gear box. It is operative when feeding in either direction, and is controlled by the collars shown on the feed rod, which may be set at any desired point in its length. The feed can be reversed by the handle shown in the lower right-hand corner of the apron.

The lathe is equipped with a heavy plain tool block having power cross-feed. The tool used has a section of ⅝ inch by 1¼ inch. The machine swings 19⅛ inches over the bed, and 13¼ inches over the carriage. With a 6-foot bed, it takes 24 inches between centers. The countershaft is driven by 5-inch belts running over 12-inch pulleys, provided with full 12-inch diameter rim frictions. The net weight of the machine with the 6-foot bed is 2,500 pounds.

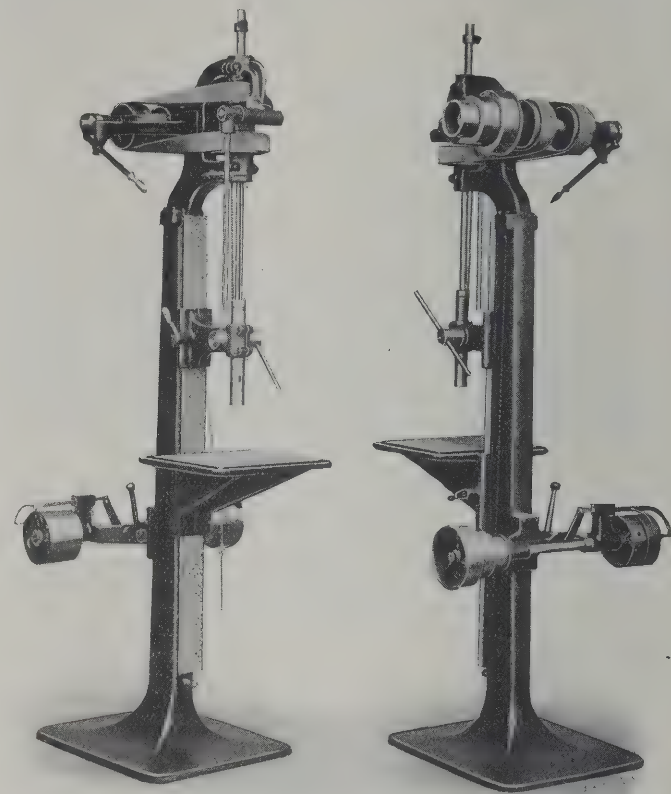


A Heavy, Simplified 18-inch Lathe, adapted to Rapid Reduction Work

KERN 15-INCH DRILLING AND TAPPING MACHINE

The attractive looking tool shown herewith is a new product of the Kern Machine Tool Co., 4657-4659 Spring Grove Ave., Cincinnati, O. It is especially designed to handle light drilling and tapping in an expeditious manner, being so proportioned and contrived as to combine strength, ease of manipulation and accuracy.

As a drill press, it combines the features expected in a machine of the sensitive type. By a very ingenious provision six spindle speeds are obtained with very little complication.



An Ingenious and Effective Combination of Sensitive Drill and Tapping Machine

The provision for doing this makes use of the tapping attachment, as will be understood from a study of the engravings. The counter-shaft mounted on the rear of the machine carries a three-step cone pulley belted to a mating pulley on the jack-shaft at the top of the machine. A double quarter-turn belt connects this with a large and small pulley, either of which may be engaged with the drill spindle by the operation of a friction clutch controlled by the vertical lever shown hanging down at the front of the machine. Owing to the difference of diameter of these two pulleys, it is evident that the three speeds obtained by the cones can be doubled, giving six, by connecting either the slow forward or fast reverse pulley with the spindle. The fast reverse speeds, however, would run the drills backward. To obviate this difficulty, a positive clutch is provided on the jack-shaft, by which it may be connected to either one of the quarter turn pulleys, making either of them the driver, while the other revolves idly. By this means the spindle may be reversed independently of the regular tapping attachment handle, so as to make the three fast reverse speeds available for drilling.

As a tapping machine, the tool would seem to have unusual advantages. The spindle pulleys are driven by a continuous belt, insuring a steady drive. The frictions are self-adjusting, allowing any tension to be put on that the operator may desire. The driving of the spindle by friction clutches minimizes the danger of breaking taps, since they may be so set as to permit the friction to slip, well within the breaking strength of the tap. The arrangement also permits a rapid starting, stopping and reversal of the spindle without shock or jar, whether in drilling or tapping work. An adjustable screw for the specially made endless belt is provided to increase or lessen its tension as required.

The drill has a total height of 79 inches, or of 99 inches

with the spindle extended. The spindle, which is counterbalanced, has a movement of 5½ inches. A driving socket for No. 2 Morse taper is provided. The table is 12½ by 14 inches, and is of the square type with a surrounding oil groove. The machine is also provided with a cup center and V-block. Both table and head are vertically adjustable on the column of the machine. The machine drills to the center of a 15-inch circle. Its net weight is 425 pounds.

FERRACUTE DOUBLE-CRANK TOGGLE-JOINT DRAWING PRESS

Presses for drawing seamless sheet metal shells are commonly designed with an outer ram or blank-holder, and an inner ram or plunger, thus making a double-acting press, as distinguished from the single-acting press which has but one ram. The outer ram may be held in position after having been moved down by various mechanical devices. The method most commonly used is to employ cams on the main shaft, and for certain shapes and sizes heavy springs are employed. A better and more modern device, however, is the use of a toggle- or knee-joint, which enables the pressure between the blank-holding surfaces of the dies to be taken more directly by the frame. This obviates the loss of power resulting from friction when the pressure is sustained by the crank-shaft. The press shown in the accompanying illustration is built on the toggle-joint principle, and has recently been placed on the market by the Ferracute Machine Co. of Bridgeton, N. J. It was designed by Mr. Oberlin Smith, president and mechanical engineer of the company.

The frame of the press is massive. The trussed bed, rests on shelves in the columns, to which it is securely bolted; each column is reinforced with two 4½-inch steel rods as shown in the illustration.

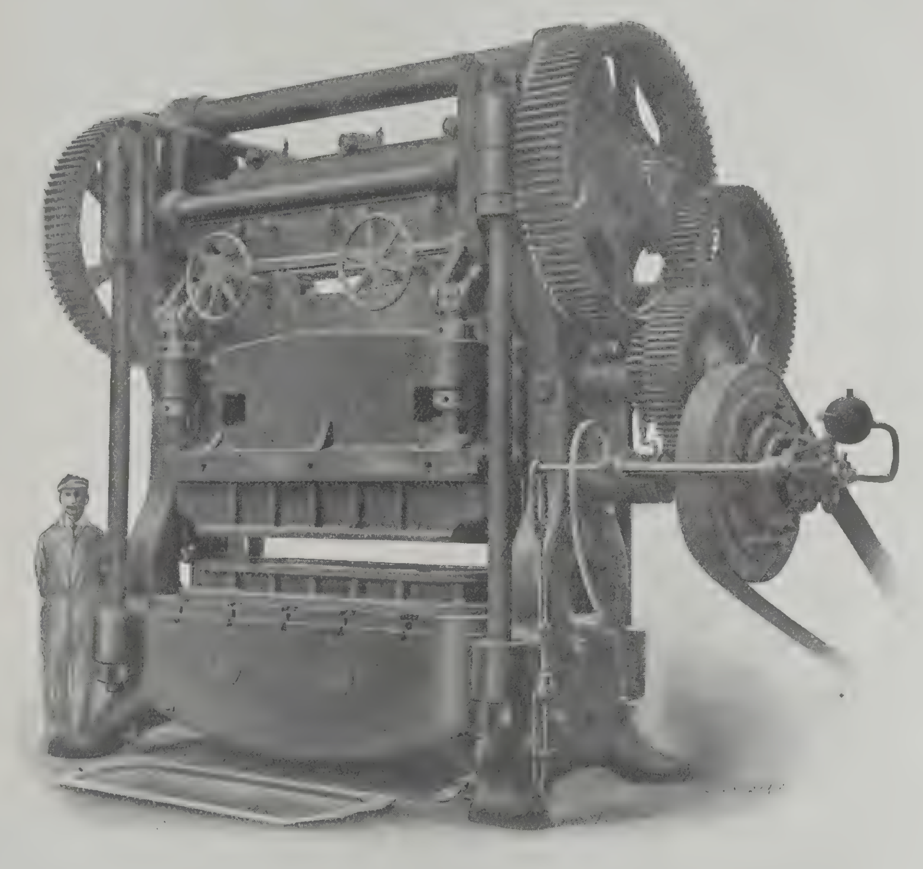
The ram and plunger have each an adjustment of 6 inches. The ram is adjusted by means of the round nuts shown in the engraving, and the plunger by means of the hand-wheels. The crank-shaft is forged from high carbon steel, and is 10 inches in diameter. It is reinforced by the long pitman-strap which unites the shaft and the plunger, the connection being made by two pitman stems. The latter are threaded and made to revolve simultaneously when adjusted by means of a shaft provided with two bevel gears. A link-belt joins the hand wheels, so that both revolve in the same direction when one is turned.

Two yokes, one on each side of the press, are attached to the plunger. These yokes have a vertical motion of 15 inches, the same as the stroke of the plunger. On the extensions of the middle toggle pins, rollers are provided, guided in slots in the yokes, the toggles being thereby straightened out at each stroke. The upper ends of the toggles are attached to the columns, and the lower ends to the outer ram.

The stroke of the outer ram is 6 inches, the plunger, as already mentioned, having a 15-inch stroke. The distance between the two columns is 100 inches, and the depth of the bed from front to back is 48 inches. The size of the hole in the bed is 60 inches by 18 inches. The distance from the bed to the outer ram at the top of the stroke, and in its extreme adjustment, is 32 inches, and to the inner ram or plunger, 35 inches.

The press is provided with triple gearing, the total ratio of which is 75 to 1; all gears are machine cut. The back-shaft is of unusually large diameter, and the large gears mounted on the main shaft are of the same size at each end, which relieves the shaft from torsional stresses. These gears are 5 feet in diameter and have a face 10 inches wide. The fly-wheel is 40 inches in diameter and has a face 7 inches wide, and runs at an average speed of 500 revolutions per minute. This gives a speed of from 6 to 7 strokes per minute to the press. A friction clutch is provided by means of which the ram may be stopped at any given point of its stroke. In the illustration the press is shown equipped with a positive knock-out.

The weight of the press is 94,000 pounds, the height being 13 feet, the width 16 feet and the length or depth 7 feet. The pressure exerted is 500 tons. It is designated by the makers as "Press SA175."



Double-crank Toggle-joint Drawing Press of Large Dimensions, built by the Ferracute Machine Co.

LE BLOND HEAVY-DUTY LATHE EQUIPPED FOR CRANK-SHAFT WORK

The heavy-duty lathe built by the R. K. Le Blond Machine Tool Co., of 4609 Eastern Ave., Cincinnati, O., described in the New Tools department of the September, 1909, issue of MACHINERY, was intended to produce a high output in a wide range of machine work. A modification of this design has been developed by the builders to meet the requirements of manufacturers who have large quantities of duplicate lathe work, but are unwilling or unable to invest their capital in attachments which, for them, would be useless.

The changes made in this simplified design (known as the "heavy-duty automobile lathe") relate, as may be seen from Fig. 1, principally to the spindle drive and feed mechanisms. The head-stock remains the same as on the machine previously referred to, with the exception of the back gearing. Two back gear ratios are provided as before, but the change from one to the other is made with a sliding key operated by the hand lever directly in front of the driving cone. This replaces the double friction clutch arrangement used and found necessary for quick changes on a general purpose tool.

The quick change gear box is replaced by one giving four rates of feed. The changes are obtained by sliding gears operated by the crank handle shown at the front of the box. The four changes are doubled by a reversible compound gear arrangement on the end of the bed, thus giving the operator a choice of eight geared feeds covering a wide range. As before, the apron is double walled and built of a single box section casting. The lead screw and split nut are removed, however, along with the quick change gear device.

The lathe is shown equipped with a set of tools of a type which has recently come into favor for automobile crankshaft work. The tools are best seen in Figs. 2 and 3, where a crank (in the rough, except for the two end journals) is having its four crank pins squared and turned. The device consists, as may be seen, of a special chuck, a tail-stock fixture, a double tool carriage and an automatic stop mechanism on the apron.

The crank-shaft is held in a split bearing in the chuck by one of the turned end journals, and is driven by the V-shaped jaw which is screwed down on the first crank arm. This jaw pivots at its back end, and is fitted with a spiral spring

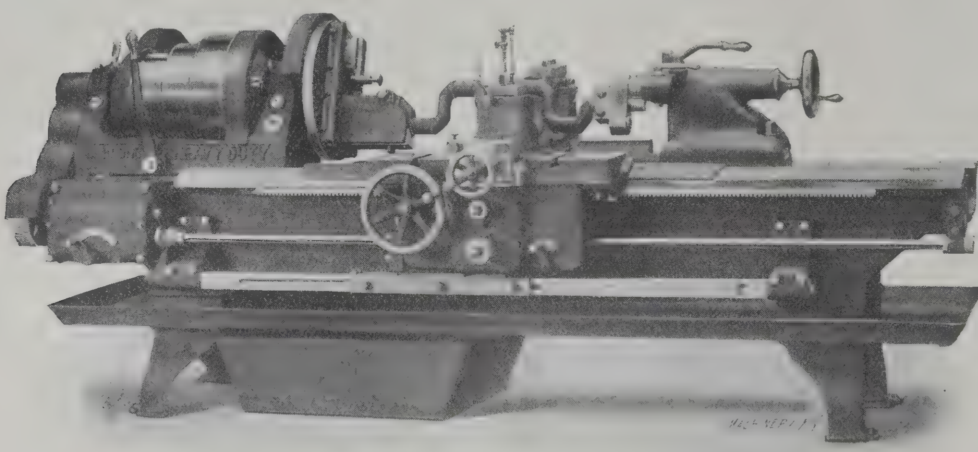


Fig. 1. Le Blond Heavy-duty Lathe arranged for Crank-shaft Work

under the clamping screw to facilitate chucking. This work holding fixture is carried on a scraped slide on the face-plate, to which it is attached by a clamp and an adjustable gib. It is accurately positioned for the two crank centers by a hardened steel locking pin entering hardened steel bushings in the face-plate, after which it may be securely locked in position by the two T-bolts. A counter-weight is provided on the back of the face-plate which is fitted with stops for its two positions, thus enabling the operator to counterbalance the crank in either position practically simultaneously.

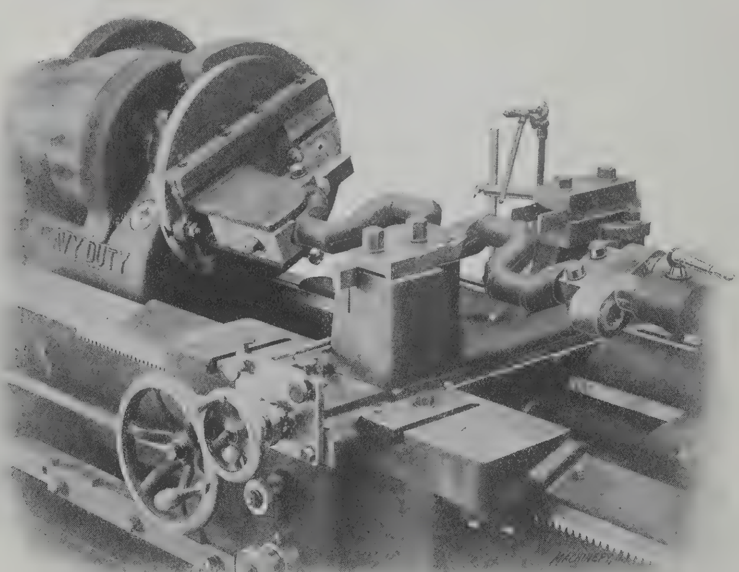


Fig. 2. Detail View, showing Special Holding Device and Tool Stops

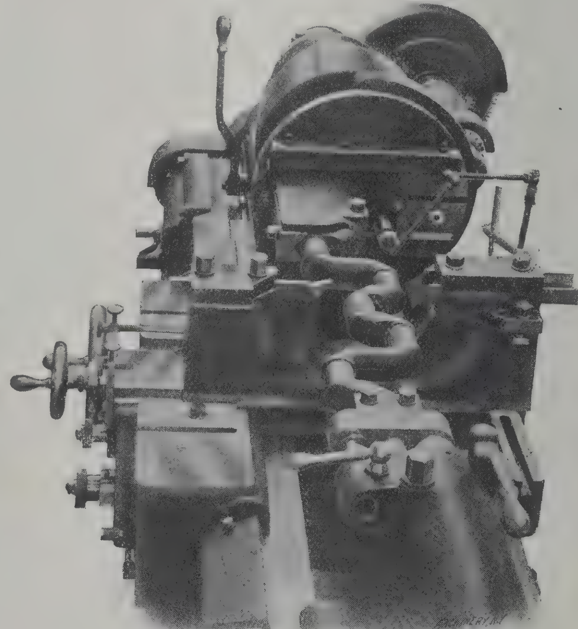


Fig. 3. The Arrangement of the Tools for Cutting the Fillets and Turning the Crank-pins

The other end of the crank-shaft is clamped at the turned journal in a split bearing in the tail-stock fixture. This fixture carries two hardened and ground bushings which are spaced the exact center distance of the crank throws; these bushings are alternately used as journals on the special tail spindle.

The tail-stock carries immediately in front of the main spindle, an auxiliary spindle, which is spaced the same distance apart as the journals in the fixture. This auxiliary spindle may be readily withdrawn by the lever shown on the tail-stock and serves a double purpose. In addition to affording a convenient means for changing the tail-spindle from one bearing to the other, it provides a means for accurately locating the tail fixture with relation to the crank throws when chucking. The alignment of the crank is accomplished by this auxiliary spindle in connection with a locking pin shown under and behind the face-plate (see Fig. 3) which enters a bushing in the head-stock.

The carriage is clearly shown in Figs. 2 and 3. The tool blocks are cast in one piece on a long slide which is mounted directly on the carriage. The rear tool block carries two tools set the proper distance apart for turning out the fillets, while the front block carries a round nose tool for removing the stock between the fillets. The movement of these tools is controlled by the stops shown on the slide, which enable the operator to duplicate diameters.

The longitudinal feed of the apron is controlled by the multiple stop-bar shown on the front of the bed in Fig. 1. The notches in this bar, which are spaced the same distance apart as the throws on the crank, engage a stop lever on the apron. In operation the carriage is, in turn, run up against each of these stops, bringing the back tools into exact position for turning out the fillets. The carriage is then returned, the front tool is run in, and the automatic feed is engaged. When the stop lever strikes the notch on the bar it operates a clutch on the feed rod and automatically throws out the feed. For crank-shaft work the stop bar is made as here shown to reduce the setting up time. When this feature is applied to a regular lathe, the stops are made independent, so that they may be set at any desired point within the range of the carriage travel.

This construction affords a convenient method for turning shafts with a number of shoulders, and the manufacturers claim that on many classes of work it gives a higher production than the more complicated and expensive turret machinery, usually installed for such work.

This simplified form of heavy duty lathe is built in 16, 18 and 20-inch swings. The machine shown in the accompanying illustrations is the 20-inch size.

BERTSCH COMBINED MULTIPLE PUNCH AND SHEAR

The framework and operating mechanism for a multiple punch and for a gate shear resemble each other closely, the only difference, practically, being in the cutting tools themselves. Advantage of this fact has been taken by Bertsch & Co., Cambridge City, Ind., to develop a combined machine which has practically the efficiency of a separate tool for either of its combined functions. This combination multiple punch and shear is herewith described and illustrated.

The frame is of the gate type, having a wide cross-head operated by eccentrics at either end. The main shaft bearings are provided with adjustable split boxes; a third center bearing of patented construction is also employed, as shown. The clutch is reliable, positive, noiseless and easily operated. It has steel-faced jaws and a cast-steel switch ring, acting against a hardened steel roller on a vertical steel plunger.

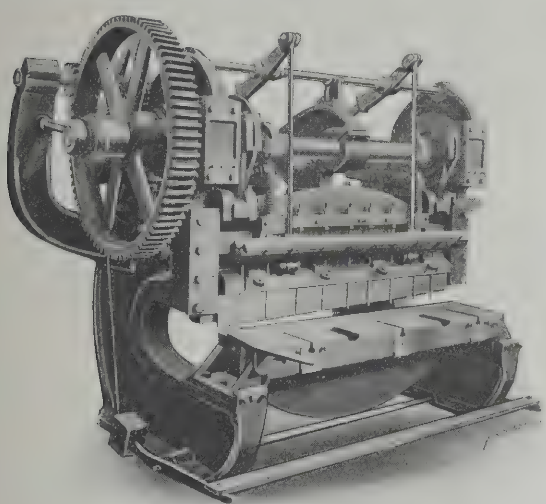


Fig. 1. Combined Punch and Shear as arranged for Plain Shearing

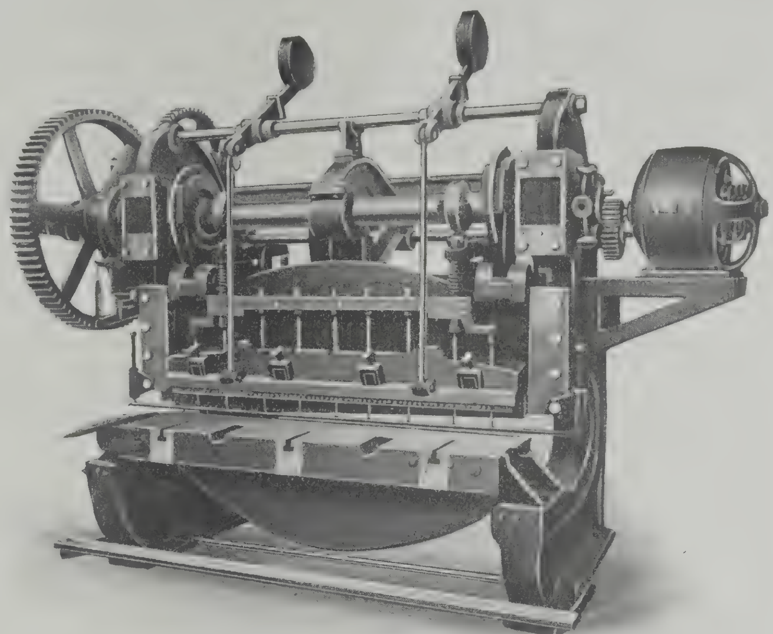


Fig. 2. Combined Machine with Cross-head swung down into Position

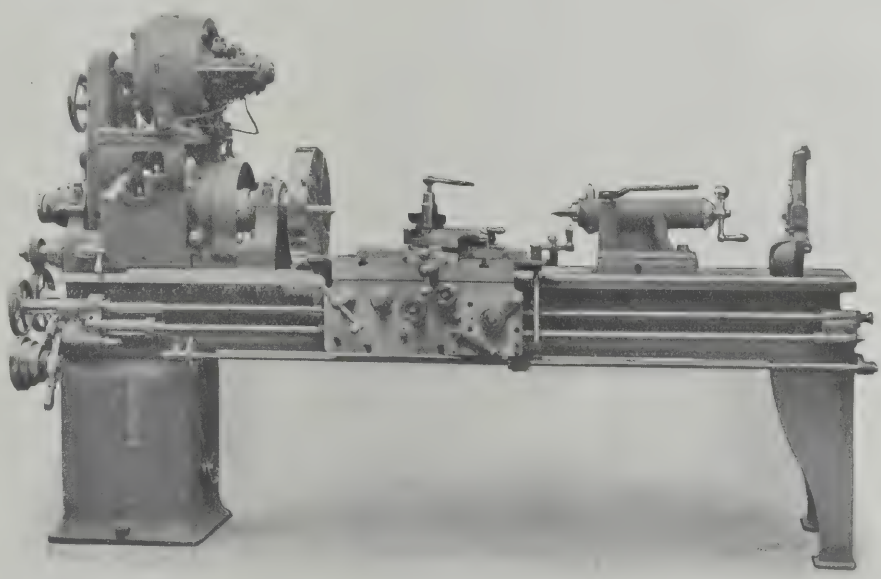
The machine is shown in Fig. 1 set up for use as a shear, and in Fig. 2 with the multiple punches in position. The latter, it will be seen, are mounted on a supplementary cross-head, hinged to the main cross-head, allowing them to be swung down into position or raised at will. Counterbalance weights are provided to facilitate this change. When engaged, this supplementary or punch cross-head is securely locked, and has a square shoulder fit along the entire length of the main cross-head which takes all the strain, none being transmitted to the hinge pins. End bearings are also provided for locating it longitudinally. The punches have either independent or universal adjustment. In the latter case they are set in an adjustable dove-tailed, steel punch-holder bar, so that the entire lot can be removed or replaced together. The punch and shear may be used together for piercing holes and trimming at one operation. The tool may be used as a simple shear as shown in Fig. 2, or as a punch only, with the upper shear blade removed.

A mechanism is provided which operates as a stripper when punching, and as a positive hold-down when shearing. This mechanism is operated by two cams mounted on the main shaft near the eccentrics. These bear down on rollers mounted on rock-shafts connected through the springs and rods shown, with a frame carrying a number of vertical rods. These latter serve as hold-downs for plain shearing work, and are of such construction as not to obscure the vision of the operator. They are of material assistance in safeguarding him when working on narrow strips. These rods also serve to support the stripper bar, as shown in Fig. 2, when punching is being performed.

This machine is made in a variety of sizes ranging from 3 feet to 12 feet in length, and with maximum capacities of 14 gage to ½-inch plate. It will be furnished for either belt or motor drive.

BRADFORD 16-INCH MOTOR-DRIVEN ENGINE LATHE

The accompanying illustration shows a regular 16-inch by 8-foot Bradford engine lathe as built by the Bradford Machine Tool Co., Cincinnati, Ohio, provided with individual motor drive. In applying the motor drive, the head-stock has been practically re-designed and adapted for the special requirements presented. The motor is placed on a frame which encloses the head-stock gearing. This arrangement is of special advantage as it puts the motor in a place where it is out of the way, makes it part of the machine, and at the same time makes it easily accessible to the operator. The connection between the motor and the lathe head-stock is through spur gears. The motor is of the 2 to 1 variable speed type, and as three speeds can be obtained by means of the gearing in the head-stock when the back-gearing is not thrown in, and three speeds with the back-gearing in operation, twelve speeds in all can be obtained. By using a rheostat, any intermediate speed from the lowest to the highest is also obtainable. The lathe is provided with a friction drive for the direct gear speeds, and a positive clutch for the back-gear speeds and



Sixteen-inch Motor-driven Engine Lathe built by the Bradford Machine Tool Co., Cincinnati, Ohio

either can be thrown in while the lathe is in motion without danger of breakage. The motor speeds are operated by means of the smal lever at the right-hand end of the apron. The controller is inclosed in the cabinet leg of the lathe and is connected through sprockets, a splined shaft and bevel gearing with the lever which is operated over a graduated dial attached to the apron, as shown in the illustration. This arrangement makes all the controlling parts easy of access; at the same time, means are provided for stopping the lathe mechanically if required, independently of the electric equipment.

The lathe is in all other respects the same as the regular type of the Bradford lathes. The swing over the bed is 16¼ inches, the swing over the rest being 9 inches, and over the carriage 10¾ inches. The lathe with an 8-foot bed illustrated herewith takes 4 feet 1 inch between centers. A 1 11/16-inch hole is provided through the spindle. The spindle speeds obtainable vary from 5 to 340 revolutions per minute. The motor is 2 horse-power, but any style or make of motor can be fitted, if required; the speed of the motor can be varied from 600 to 1,200 revolutions per minute. The lead-screw has four threads per inch, and the lathe cuts threads from 2 to 40 per inch, including 11½ threads per inch. The weight of the lathe having an 8-foot bed, as illustrated, without motor, is 2,600 pounds net.

WELLS MOTOR-DRIVEN AUTOMATIC SCREW MACHINE

The accompanying illustrations, Figs. 1 and 2, show an automatic screw machine with individual motor drive, placed on the market by the F. E. Wells & Son Co., Greenfield, Mass. This machine is, in general, of the same design as the regular automatic screw machine built by the company, including the patented method of camming, and independent cross slides. In addition, however, this machine is provided with the advantage of direct motor drive, the power being transmitted through a speed changing device, involving the use of sliding gears, by means of which three changes of speed for the spindle are obtainable. The change gearing is shown in the rear view, Fig. 2. This speed changing device can, of course, also be used for driving the machine directly from a pulley on the main line-shaft by belting directly to the pulley which is now driven from the motor; the same number of speed changes are then obtainable. The advantage of being able to easily change the speed enables greatly increased production on an automatic machine.

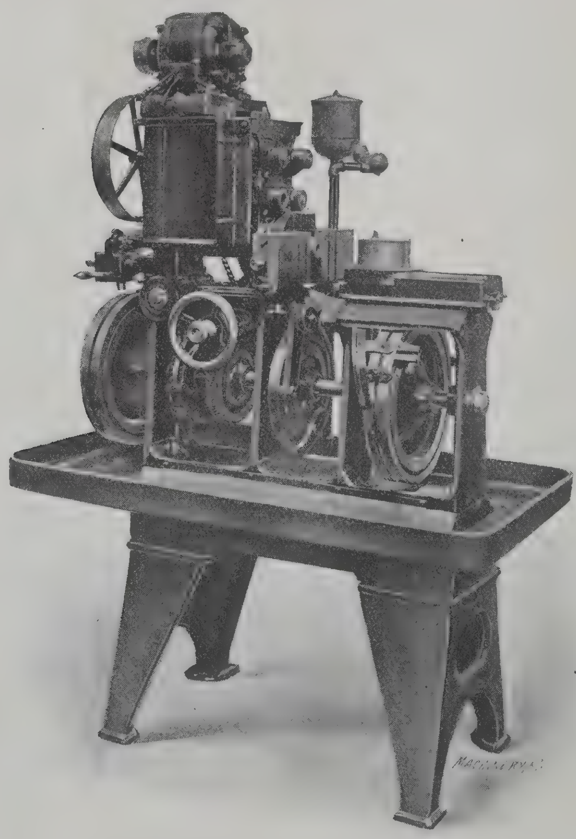


Fig. 1. Front View of Motor-driven Automatic Screw Machine, built by the F. E. Wells & Son Co., Greenfield, Mass.

Another novel feature is the method of transmitting the power from the motor to the main driving pulley without appreciable loss through the slipping of the belt. This method has been used for some years past on some classes of wood-working machinery, but has not been in vogue on metal working machines. Pins are set into the small driving pulley on the motor and the driving belt is provided with small corresponding holes. This prevents the belt from slipping when running over the small pulley, although the center distance between the two pulleys is small and the difference between their diameters marked.

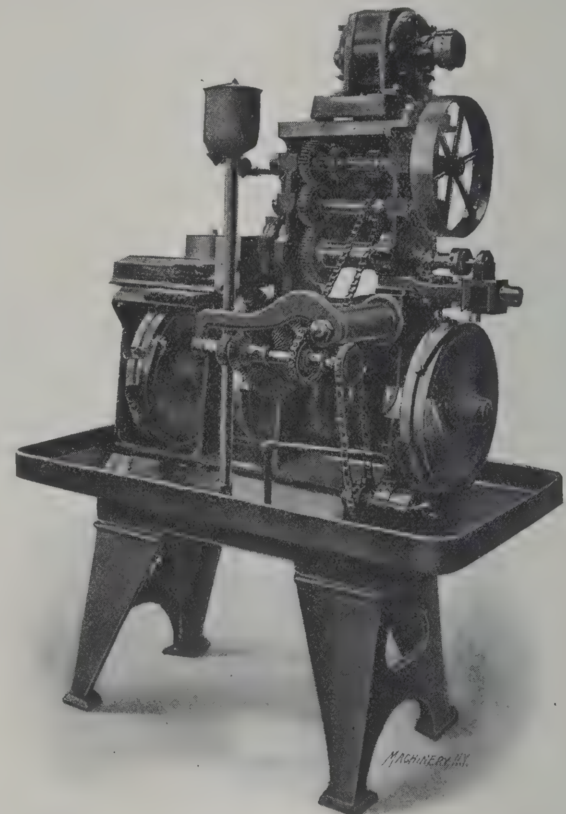


Fig. 2. Rear View of Wells Automatic Screw Machine, showing Driving Mechanism

AMERICAN TWO-FOOT AND THREE-FOOT RADIAL DRILLS

In the April, 1909, issue of MACHINERY, a 2-foot sensitive radial drill, built by the American Tool Works Co., 300-350 Culvert St., Cincinnati, O., was illustrated and described. This machine has proved very popular, and the firm has been forced, on account of the large demand, to bring out special designs of this drill in addition to the original design previously described. In Fig. 1 is shown one of these special designs, illustrating the 2-foot radial drill provided with motor drive and tapping attachment. As will be seen from the illustration, a Lincoln variable speed 3 to 1 motor is mounted beneath the box table. The speeds of the motor vary from 525 to 1,575 revolutions per minute, and the motor is under perfect control of the operator by a hand-wheel shown conveniently placed under the table in front of the motor. The tapping attachment is directly connected with the main belt drive and is controlled by the lever shown at the base of the column. The arrangement of the belting from the driving pulley in the rear at the left-hand side of the machine, to the vertical driving shaft is of particular interest, providing as it does on the one hand a convenient drive in a case where short center distances and the angularity of the drive make the arrangement rather difficult, and on the other a simple drive for the tapping attachment. It will be noted that there are no gears in this drive, either at the base or at the top of the machine, the power being transmitted throughout by belts. Means are provided for regulating the tension of the belts both overhead and below. The frictions in the tapping at-

tachment are of the American Tool Works patented type, and cannot become disengaged accidentally after they have once been thrown in. They are of ample proportions to transmit the maximum power the machine is intended for. The machine has a capacity for high-speed twist drills up to 1-inch diameter, and 1-inch standard taps. It may be fitted with a tapping chuck, making it particularly adapted for tapping small holes. The general design of the machine in all other details is identical with that described in the April, 1909, issue.

In Fig. 2 is illustrated the 3-foot American radial drill mounted on a pedestal base and not equipped with a box table. This type of machine is particularly convenient for drilling a great number of holes in work which can be conveniently moved on a truck, or otherwise, beneath the spindle of the machine. This arrangement eliminates to a considerable extent the handling of the work, and permits of its being moved from the drilling department to the next department with the least possible delay. The machine will be found of particular advantage in automobile and gas-engine manufacturing plants, and it is due to the requirements of manufacturers of this class of machinery that this type has been designed. When drilling with a jig the work can be carried out very rapidly, as the arm is easily swung to any position desired and the head rapidly moved to any point along the arm. A spindle speed as high as 900 revolutions is available, but this may be increased or diminished to suit special requirements. The bearings are all of the ball-bearing type, and the drill will run up to a speed of 2,000 revolutions per minute without signs of distress, but of course no twist drill would hold its edge long at such a speed.

In its general details the design of this machine is identical with the 2-foot drill, excepting, of course, that the dimensions are proportionately larger. The two machines illustrated show interesting examples of the possibility of adapting standard machine tools, built on the unit plan system, to different requirements by simply changing some of the details.

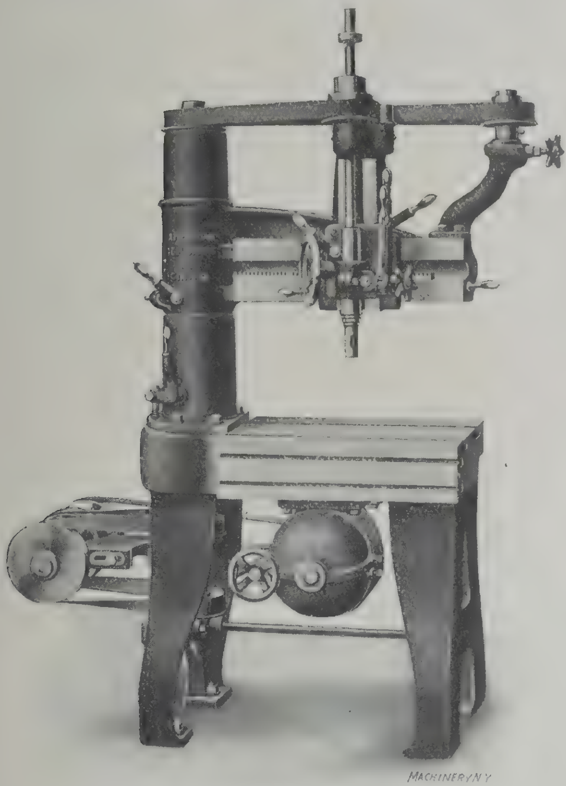


Fig. 1. American Tool Works Co.'s 2-foot Radial Drill with Motor Drive

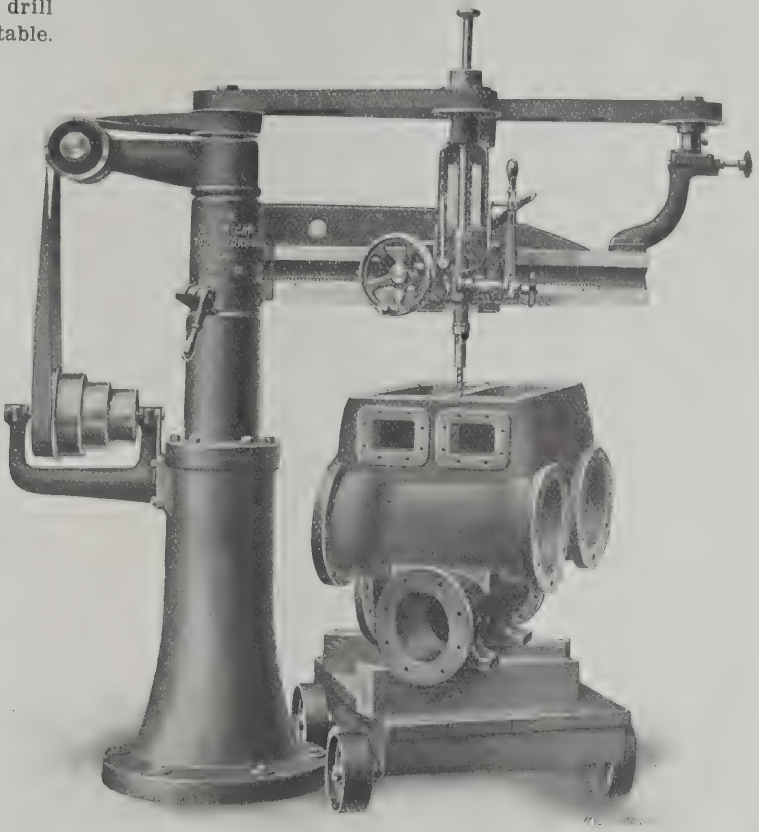


Fig. 2. Sensitive 3-foot Radial Drill, especially adapted for Automobile and Gas Engine Manufacture

The accompanying table gives some results obtained in drill tests undertaken with this machine. The table gives the diameter of drill, the revolutions per minute, the cutting speed, and the feeds per revolution and per minute, stating as well the horse-power required for driving.

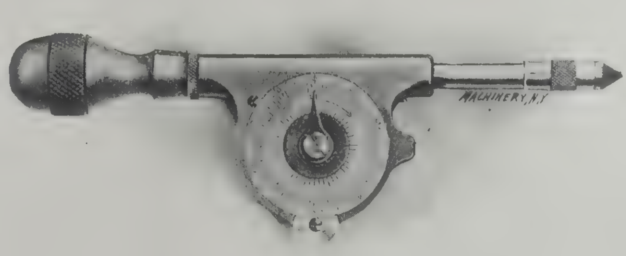
DRILLING TEST—AMERICAN SENSITIVE RADIAL DRILL

Diam. of Drill, inches	Speeds		Feeds		Net Horse Power	Remarks
	Revs. per min.	Feet per min.	Approx. per Rev.	Inches per min.		
$\frac{1}{4}$ C.	900	59	......	......	0.15	Cast iron 1″ thick
$\frac{1}{2}$ H.S.	900	137.2	0.022	20	1.50	Cast iron 1″ thick
$\frac{5}{8}$ H.S.	900	147.2	0.013	12	3.0	Cast iron 1″ thick
$\frac{3}{4}$ H.S.	900	177	0.013	12	3.7	Cast iron 1″ thick
1 H.S.	455	119	0.0066	3	2.6	Cast iron 1″ thick
1 H.S.	785	207	0.0076	6	3.2	Cast iron 1″ thick
$\frac{1}{2}$ H.S.	900	137.2	0.037	16.8	1.2	Aluminum engine frames*
$1\frac{19}{64}$ H.S.	745	248	....	......	0.9	Aluminum case†

* ½″ thick. Drilled 14 holes in 25 seconds
† Drilled from the solid. Bosses drilled and faced in one operation

BROWN & SHARPE SPEED INDICATOR

A new speed indicator has been brought out by the Brown & Sharpe Mfg. Co., Providence, R. I. The new indicator is provided with two features which, in particular, will make it valuable. In the first place the indicator is equipped with a dial for registering the speed, on either side of the case. One side is used for ascertaining the velocity of shafts and spindles running in the right-hand direction, and the other side for determining the speeds of shafts running in the left-hand direction. The confusion and errors which are not uncommon when all readings are taken from one dial are thus avoided. The indicator registers revolutions in units, tens



Improved Brown & Sharpe Speed Indicator, with Dials on Both Sides of the Case

and hundreds. The second feature of importance is a small knurled wheel on the side of the case which provides a means for quickly readjusting the device after the reading has been taken. This wheel when turned revolves the disk indexing hundreds back to the starting point. This feature is of value when a series of readings is to be taken, as it saves a considerable amount of time and makes rapid and exact readings possible.

The indicator is small and light and provided with a polished wooden handle. The working mechanism is encased, and protected from dirt and injury by a heavily nickel-plated cover having a dull finish. The point is of hardened steel, and can easily be removed when worn, and replaced if required.

GORTON HEAVY-DUTY CUTTING-OFF MACHINE

A heavy-duty cutting-off machine has recently been placed on the market by the George Gorton Machine Co., of Racine, Wis. As may be seen by referring to the illustration of the machine, Fig. 2, it is exceedingly stocky and rigid in its design, and the aim of the builders has been to produce a tool capable of feeds and speeds heretofore unattainable. The bed and cutter head are both exceptionally massive, and chatter and vibration, which are inevitable in improperly designed machines of this type, have been eliminated. In addition to the rigidity, the large diameter of the main driving gear and the directness of the drive add largely to the efficiency of the tool.

The bed is a one-piece casting, heavily ribbed internally, which has its entire bottom cast solid, thus forming a reservoir for the cutter lubricant. Mounted upon this bed is a heavy cutter slide which contains the large driving gear, shown in Fig. 1, to which is attached the cutter blades and cutters. The cap which forms the upper half of the large drum bearings for this main driving gear, is bolted to the slide as shown. Cast integral with this cap are the brackets for the motor, and at the left are located the bearings for the main driving pinion which meshes with the main driving gear. The pitch diameter of the main gear is 60 inches and its face width 3½ inches, while the pitch diameter of the driving pinion is 5 inches and the face width 4 inches. The driving pinion is forged integral with its 3-inch crucible steel shaft, and the angle of the drive is such that comparatively little pressure is placed on the cutter drum bearings. Attached directly to this cutter drum, which is made of fine-grained metal (25 per cent steel), is the cutter blade of 0.60 carbon steel. This cutter blade fits accurately over ten hardened and ground steel studs which are driven into the drum, and it is additionally secured by ten ⅞-inch special screws as shown. For belt-driven machines, the driving clutch pulley is mounted directly upon the main pinion shaft. The lever which operates this clutch is seen at the front side of the machine directly over the stock vise. It is connected with the cone which expands the clutch by a rod passing through the pinion shaft, which is hollow. When the machines are electrically driven this clutch pulley is replaced by a clutch gear. The lever by which the clutch is operated is used to start and stop the machine.

This machine is designed for cutting off round stock from 1½ to 6 inches in diameter, and square bars with widths from 1½ to 5½ inches. If necessary, round stock up to 8 inches in diameter may be severed by back feeding 2 inches by hand. The bars are held in the powerful clamping vise shown, which is equipped with hardened tool steel jaws. In addition to this vise there is a trolley for supporting the outer end of the bar. This trolley runs on a track, consisting of two 7-inch channels, which on a standard machine is 22 feet long. If required, special tracks 32 or 42 feet in length will be furnished. The trolley is provided with a positive measuring arrangement which permits the stock to be cut off to the required lengths. When a piece is severed it is forced through a trough at the rear into a truck, onto the floor, with little effort on the part of the operator.

The feeding mechanism on the standard machine is driven by 7-step cone pulleys, and a change of feeds is available which ranges from 1½ to 6 inches per minute. It has been the experience of the makers that this method of driving is preferable to the all-geared drive. The lower cone pulley is connected with a gear-box containing forward and quick return feed clutches which are operated either by hand, or automatically with a positive knock-out at the extremes of the stroke, adjustment being provided for various diameters of stock.

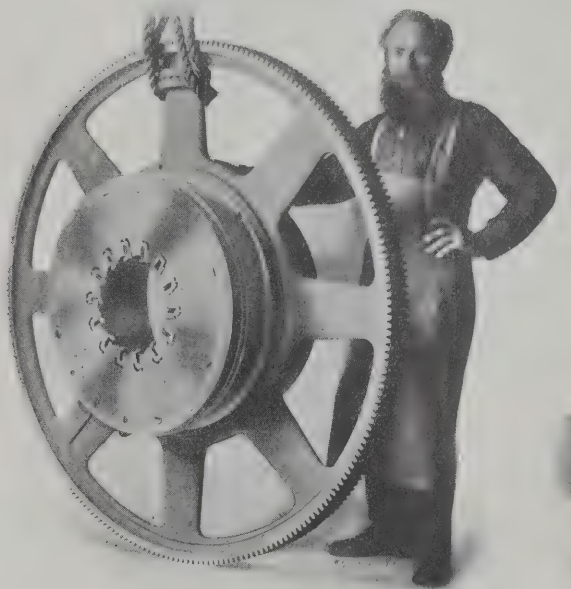


Fig. 1. Main Driving Gear of the Gorton Cutting-off Machine

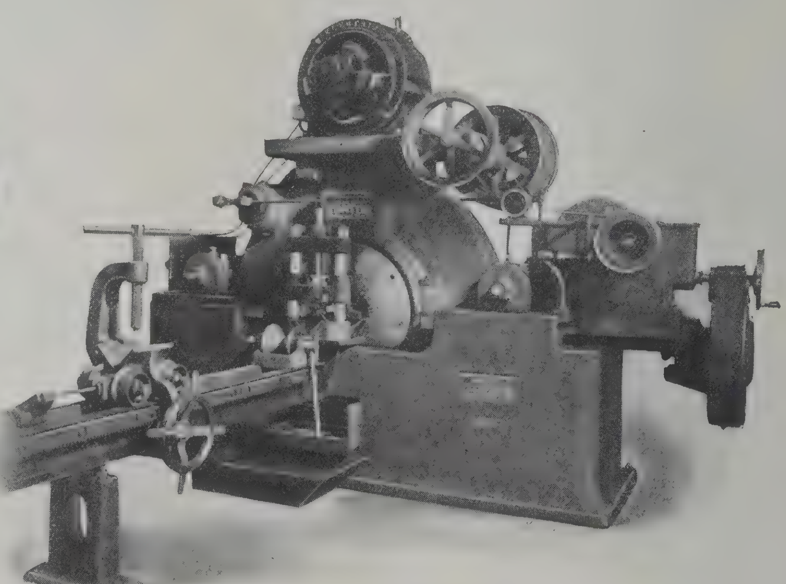


Fig. 2. Heavy-duty Cutting-off Machine, built by the George Gorton Machine Co.

Particular attention has been given to all lubrication details throughout the machine. The large cutter drum bearings which are of lumen bronze and interchangeable are flooded with oil, which is delivered into cored ways on the inside of the upper drum cap. The box-shaped extension for this oil may be seen just above the cutter blade, and in it there is a removable felt pad through which all oil entering the bearings must filter. This provision insures a lubricant which is free from grit. The main pinion bearings are equipped with a ring-oiling device, and are also flooded from the main driving gear. All the mechanism in the upper front gear case operates entirely below the surface of the oil.

Three standard cutter blades of different thicknesses are carried in stock, all of which are interchangeable. One of these blades is 7/16 inch thick, contains twelve 7/16 inch high-speed cutters, and is adapted for work ranging from 4 to 6 or even 8 inches in diameter. For cutting off stock ranging from 2 to 6 inches, a blade ⅜ inch thick is recommended; this contains fourteen ⅜ inch high-speed cutters and is the blade furnished with the machine unless otherwise specified. For smaller stock than that mentioned, a blade ¼ inch thick is provided

which contains sixteen ¼ inch high-speed cutters. If necessary, even this light blade can be used for severing stock up to 8 inches in diameter, but it will not stand the heavy feeds possible with the heavier blades. With each size of blade a cutter-setting gage is furnished for setting the re-ground cutters uniformly. It requires less than one minute to remove a broken cutter from the blade and replace it with a new one, and the breaking of a cutter while the machine is in use does not injure the blade.

The lubricant for the cutters is delivered by means of a geared pump, shown on top of the upper gear case. As a copious supply of lubricant should be used, the machine is equipped with a nozzle which will deliver a stream about four inches wide and one-quarter inch thick directly onto the saw cut. The chips fall on suitable screens which are contained in the chip pans shown in the side openings of the base. These screens effect the separation of the cutter lubricant from the chips which are raked from them into pans on the floor. All the collars, levers, hand-wheels, yokes, etc., on this machine are of steel, and all the nuts and screws are finished and casehardened. The parts are all interchangeable, and the makers guarantee the workmanship and finish equal to that of the best machine tools built.

MECHANICS' MACHINE CO.'S 20- AND 26-INCH UPRIGHT GANG DRILLS

The accompanying illustrations show two sizes of upright gang drills brought out by the Mechanics' Machine Co., Rockford, Ill. In Fig. 1 is shown what is known as the 20-inch gang drill. In this, the individual drill heads with their frames, cone pulleys and gearing are mounted on a box column as indicated, the drills being built in gangs of 2, 3, 4, 5 or 6 spindles. Each drill is independent and can be stopped, started, or its speed changed, without interfering with the other drills, each having its own individual counter-shaft, operated through a foot lever, shown in the front of the machine. The work table slides on ways on the main column, and is supported on its edge by adjusting screws as indicated.

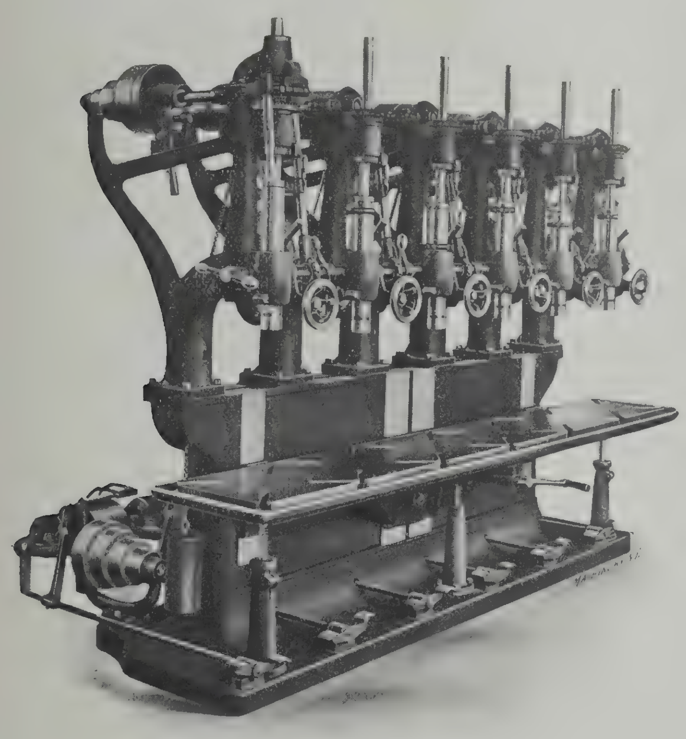


Fig. 1. Twenty-inch Six-spindle Gang Drill, built by the Mechanics' Machine Co., Rockford, Ill.

The maximum height of the drill with the spindle in its highest position is 84 inches, and the minimum height 75 inches. The distance from center to center of the spindles is 16½ inches, and the distance from the center of the spindle to the column is 10½ inches. The spindle, which is provided with a No. 3 Morse taper, has a diameter of 1⅜ inch and a vertical travel of 11 inches, and the spindle speeds are 0.005, 0.008, 0.011 and 0.014 inch per revolution of spindle. The size of the planed surface of the table for a 2-spindle machine is 14½ by 32½ inches, with an additional 16½ inches in length for each spindle added. The vertical travel of the table is 13 inches, and the maximum distance from the spindle to the table is 26½ inches, the minimum distance being 4 inches. The floor space required for the 2-spindle drill is 55 x 34 inches, for a 3-spindle drill 55 x 51 inches, an additional 17 inches in length being required for each spindle added. The weight of the 2-spindle machine is 1,900 pounds net, with an approximate addition of 800 pounds for each spindle added.

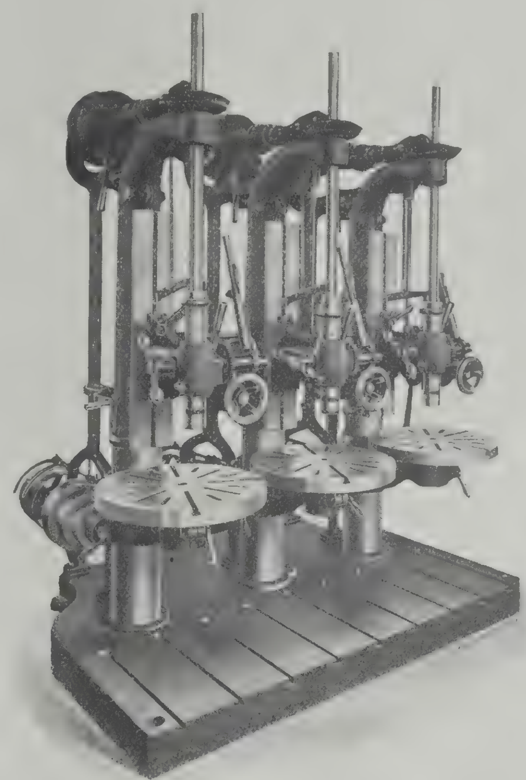


Fig. 2. Twenty-six inch, Three-spindle Gang Drill

The 26-inch gang drill in Fig. 2 is, as shown, of different design, it consisting of several practically complete upright drills mounted on a common base-plate. The design of the individual drills is also different from the design of the smaller drills shown in Fig. 1, these drill presses having sliding heads as indicated in the illustration. The 26-inch drill is supplied in gangs with 2, 3 or 4 spindles on the same base, and is furnished either with the ordinary round tables shown in the illustration, or with square tables having an oil groove or receptacle around the edges. These drills are furnished with back-gearing and positive feed; a geared tapping attachment or friction clutch tapping attachment can be furnished with one or more spindles, as required.

The maximum height of the 26-inch drill press with the drill spindle in its highest position is 87 inches; the maximum distance from the spindle to the base is 50 inches and the minimum distance 17 inches. The maximum distance from the spindle to the individual round table is 37 inches, the spindle being capable of reaching completely down to the table when in its lowest position. The distance from the column to the center of the spindle is 13 3/16 inches, the vertical feed of the spindle is 11½ inches, and the movement of the sliding head is 23 inches. The distance from center to center of the spindles is 24 inches. The floor space required for a drill press with two spindles is 48 by 67 inches, for three spindles 72 by 67 inches and for four spindles 96 by 67 inches. The net weight of the two-spindle 26-inch gang drill is 3,400 pounds, with approximately 1,700 pounds added for each additional spindle. A 24-inch and a 32-inch drill are also made in gangs, the same as the 26-inch drill. The general design of these two sizes is the same as that of the 26-inch drill.

"PEERLESS" PORTABLE ELECTRIC CHIPPING HAMMER

The electric hammer herewith illustrated and described is made by the Cincinnati Electrical Tool Co., 650 Evans St., Cincinnati, O. So far as we know, this is the first strictly electric hammer to be put on the market, there being in this tool no interposition of mechanical or pneumatic mechanism between the ram of the hammer and the source of the current.

The tool receives its current supply from an attachment connected with an ordinary direct current lamp socket. From

Fig. 1. An Electrically-operated Chipping Hammer, arranged with Lamp Socket Connection

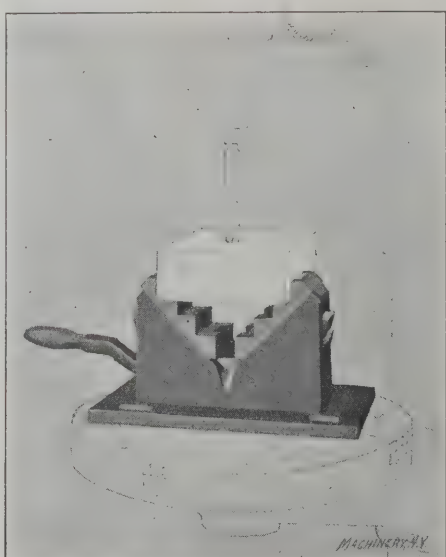
here it is led to the box shown, which contains an automatic switch mechanism for controlling the current movement throught the triple cable leading to a pair of solenoids contained within the hammer casing. When one of these solenoids is energized, the ram is raised; the energizing of the other draws the ram down again. The action of the ram or plunger on the chisel is identical with that in a pneumatic hammer. The same general appearance, and the same style of grip is retained, a switch being provided in the handle of the tool for controlling it in the usual manner.

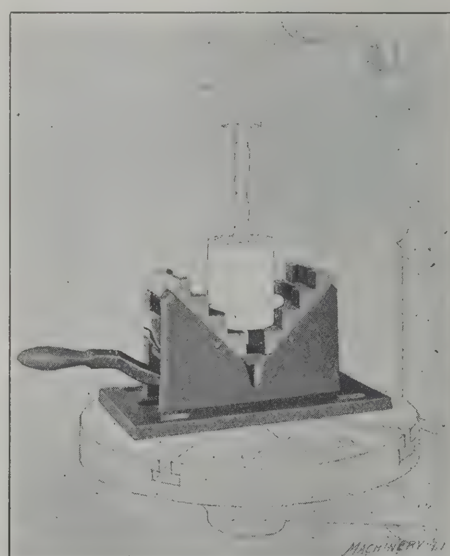
The device is light enough so that it can be carried around the shop by a boy. The box containing the switch weighs 38 pounds, and the hammer 19. The former takes a space of 7½ by 20 inches. The hammer itself is 14¾ inches long by 3½ inches in diameter. It will cut armor-plate up to ½ inch thickness.

MITCHELL-PARKS DRILL PRESS VISE

The accompanying illustrations, Figs. 1 and 2, show the general design and action of a new drill press vise brought out by the Mitchell-Parks Manufacturing Co., 612 So. 6th St., St. Louis, Mo., and known as the "Gravity" vise. The device has been designed with a view of producing a drill press vise which would be extremely simple and rapid in its operation and that would, at the same time, hold the work being drilled firmly, and which could be used on work of any size or shape. The whole vise consists of only five parts and is not provided with springs of any kind, nor does it require any special parts for special work. When the handle shown in the illustrations is raised, it brings the jaws resting on the angle guides to which they are fitted, apart. A maximum opening between the upper steps of the jaws of 8 inches and between the lowest steps of the jaws of 2½ inches can be obtained. When the work is placed in position between the jaws, its weight forces them downward along the guides, so that a firm hold is obtained on the work. When the drill enters the work, the pressure of the drill forces the jaws still further downward, and the work is gripped tighter the greater the pressure exerted on it by the drill. The jaws can therefore be said to automatically clamp the work as soon as it is placed in position. At the moment when the drill passes through the work, and the pressure of the drill on the work thus is decreased, a slight pressure on the handle will hold the work tightly so as to prevent turning at this time. Raising the handle will release the work between the jaws.

The vise may be placed loose on the drill press table except in extreme cases. When required, however, it can be easily bolted to the drill press table by means of the slots provided in the base plate of the device. The vise will hold round work from ½ inch up to 8 inches in diameter, and work of other shapes in the same proportion. The size of the base plate of the device is 7½ by 14 inches.





Figs. 1 and 2. The Gravity Vise, made by the Mitchell-Parks Mfg. Co., St. Louis, Mo.

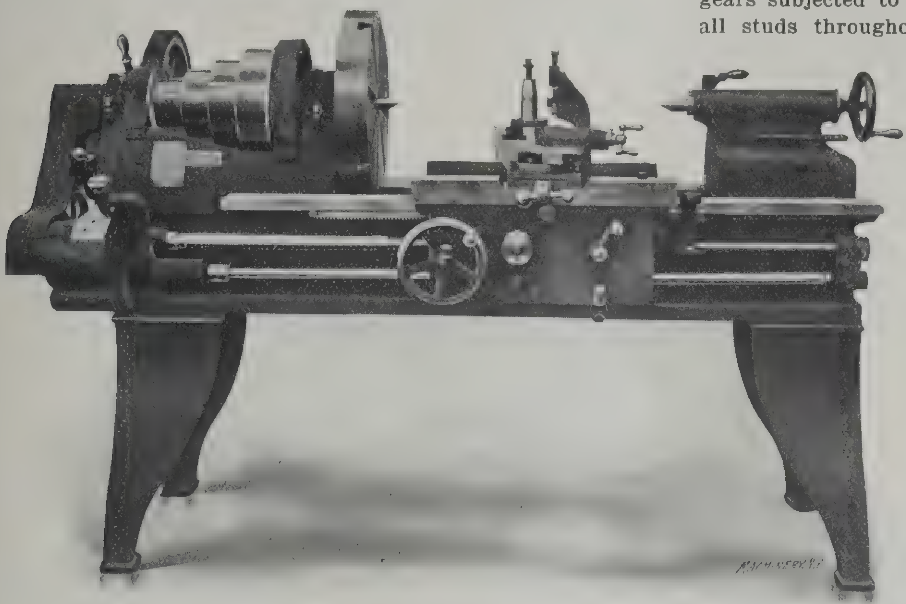
MILWAUKEE SIXTEEN-INCH LATHE

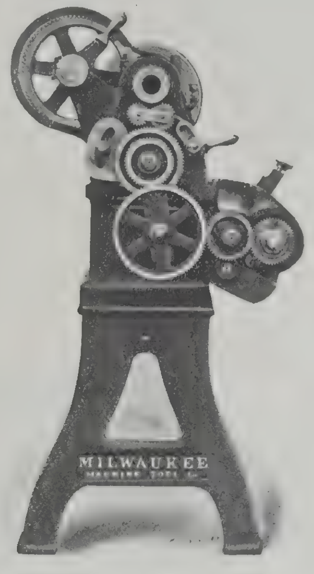
In the June, 1908, issue of MACHINERY a lathe built by the Milwaukee Machine Tcol Co., Milwaukee, Wis., was illustrated and described. The accompanying half-tones and line engraving show an improved design of the company's 16-inch lathe, recently placed on the market. In designing this lathe particular attention was given to provide an even distribution of metal, and an effort has been made to place the metal wherever it will do most good. Careful attention has also been given to produce a high-grade lathe as far as materials and workmanship are concerned. The lathe is especially adapted for general manufacturing purposes, it having the strength and power necessary for heavy work, and at the same time provision is made for convenience and adaptability for lighter jobs. The bed is heavier than in the previous designs, and is reinforced throughout with heavy cross ribs. The V's, which are planed at an angle of 45 degrees, have large wearing surfaces. The alignment of lead-screw and feed-rod has been taken care of when planing the bed, the bearing pads for these parts being planed and grooved to templets, the bearings being carefully fitted to the bed.

The Head- and Tail-stock

The design of the head-stock has been improved, it being more massive. The cone pulley has four steps instead of five as in the previous design, the width of each of the steps of the pulley having been correspondingly increased in order to permit a sufficient amount of power to be easily transmitted to the machine. The back-gearing is also made correspondingly heavy and of higher ratio. A patented spring cone stop is located in the face-gear and makes it very convenient for the operator when changing from the open belt speed to the back-gear drive. The spindle is provided with a 1 9/16-inch hole through its entire length and is drilled from the solid. It is made from crucible steel containing 0.60 per cent carbon, and is accurately ground. The bearings for the spindle are large, and are made of phosphor bronze and scraped to a bearing by hand. Two large oil reservoirs are located directly beneath each bearing, and the oil is carried to the spindle by means of a wick, which, on the one hand, keeps the spindle constantly wiped free from grit and dirt, and on the other hand affords ample lubrication regardless of speed.

The tail-stock is of correspondingly heavy design and has a long bearing surface on the bed. It is designed so as to permit the compound rest to be turned at an angle of 90 degrees, even when turning the smallest diameters. Screws are provided for setting it over sideways for taper turning, if required. The diameter of the tail-stock spindle is two inches, and the centers are provided with a No. 4 Morse taper.





Figs. 1 and 2. Side Elevation and End View of Milwaukee Machine Tool Co.'s Improved 16-inch Lathe

The Carriage and Apron

The carriage has a bearing of 23½ inches on the ways, and is gibbed to the bed for its entire length. The bearing surface on the bed is not recessed, but is in full contact from end to end with the entire depth of the V's. This eliminates to a great extent the difficulty met with in regard to vibrations or "chattering." Instead of an inside V on the front of the lathe a flat surface is used. This shortens the bridge of the carriage, and affords a solid bearing directly under the tool-post. Large T-slots are provided for clamping work to the carriage. The cross-slide and compound rest have been made heavy in proportion to the remainder of the machine, and both slides are provided with taper gibs for adjustment, thereby avoiding the necessity of manipulating more than one screw when adjusting the gib. Graduated feed collars are provided for the feed screws for both the cross-slide and the compound rest.

The apron is carefully brazed and is tongued-and-grooved into the carriage and securely bolted to it. All pinions and gears subjected to considerable strain are made of steel, and all studs throughout are made of steel and hardened and ground, except in such cases where bronze bushings are provided. The rack is of steel, and cut in one piece. A safety locking device for the half-nuts is one of the features of the lathe.

The lathe is also furnished with a thread chasing dial, a feature which should be greatly appreciated. The dial is graduated to indicate the rotation of the lead-screw, and enable the operator, when cutting screw threads, to return the carriage quickly by hand, and throw in the nut at the proper moment. This feature alone saves a considerable amount of time when cutting long screw threads, as anyone having used such an attachment will appreciate.

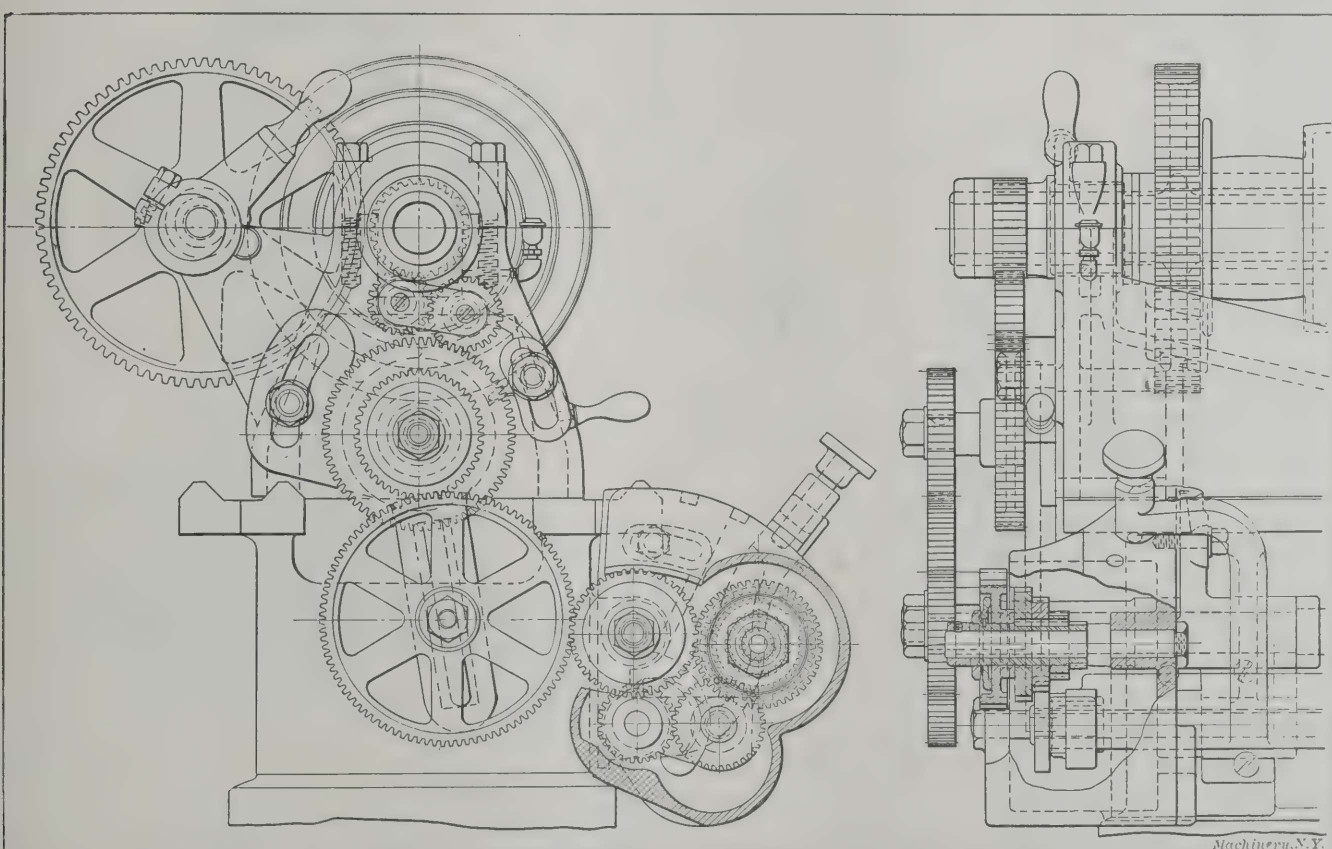


Fig. 3. Design of Feed Box and Gearing, Milwaukee Machine Tool Co.'s 16-inch Lathe

The Change Gear Box

The lathe is provided with a change gear box which gives four practically instantaneous changes of feed through the operation of one lever, as shown in Fig. 1. The drive to the gear box and its general arrangement are shown in the line engraving, Fig. 3. Through the use of change gears supplied with the machine and this gear box, a practically unlimited range of feeds and threads per inch, within the capacity of the machine, can be obtained. The construction of the gear box is very simple, it consisting merely of a cone of gears and a sliding gear which can be brought into mesh with either of the gears in the cone. A friction disk is applied to the gear drive. It is adjustable, and can give any amount of tension desired. It will eliminate to a great extent the breaking of apron parts, etc., due in many instances to carelessness on the part of the operator.

Special attention has been given to the question of gear guards, all gears in any way exposed having been properly

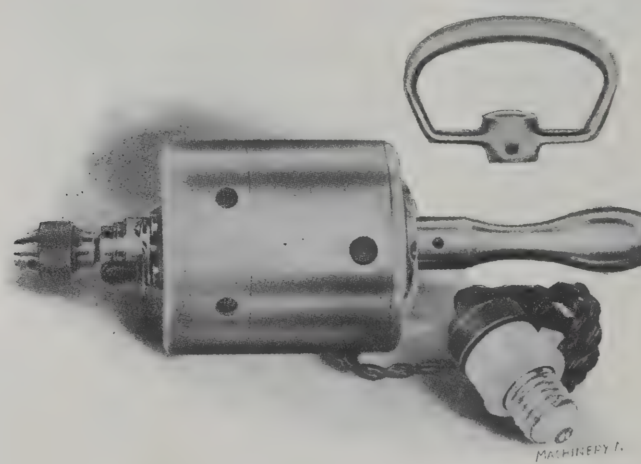


Fig. 1. "Midget" Air-cooled, Electric Drill

covered with guards. In the end view, Fig. 2, some of these guards have been removed merely in order to show the gearing, but they are well in evidence in Fig. 1. Considering the increasing requirements of the law, and the realization of the necessity of protecting the operator from possible injury, this feature is of considerable importance.

A double friction, counter-shaft is supplied with the machine in which all the wearing surfaces on the clutch are

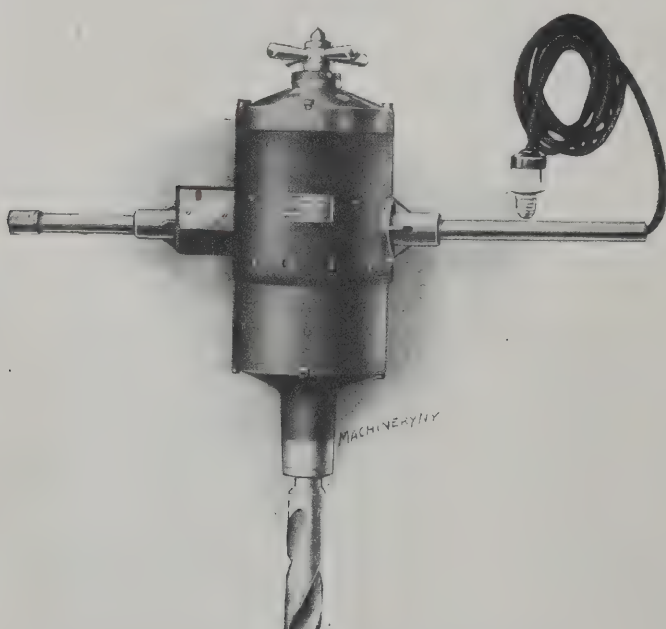


Fig. 2. Heavy Portable Drilling and Reaming Machine

accurately ground. The bearings are of the ring-oiling type, and are made of pressed steel. The hangers are made of the same material, which adds to a great extent to the strength and lightness of the construction.

The net weight of the machine with the six-foot bed is 2,200 pounds, and the approximate weight of the bed per each additional foot in length is 120 pounds.

PEERLESS AIR-COOLED PORTABLE ELECTRIC DRILLS AND GRINDERS

The tool shown in Fig. 1 (made by the Cincinnati Electric Tool Co., 650 Evans St., Cincinnati, O.) is exceptional for its lightness of weight, as compared with the size of drill it will use. Its actual weight (including the chuck) is only 4½ pounds, and it will drill holes up to 3/16 inch in steel. The style shown is made for direct current, but a similar tool is made for use with various voltages of alternating current.

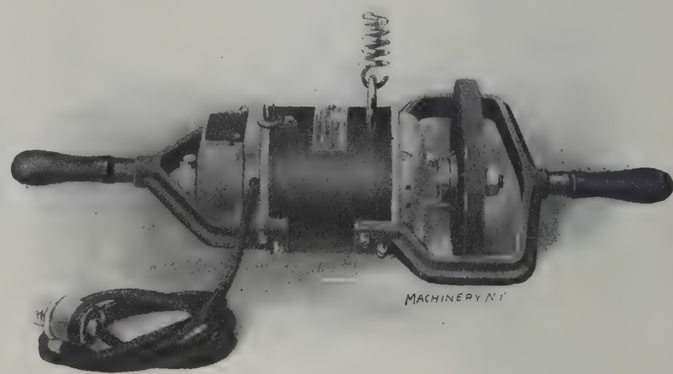


Fig. 3. A Suspended or "Aerial" Grinder for Heavy Duty

The largest size of portable drilling and reaming machines made by this firm is shown in Fig. 2. This machine is designed to drill holes in steel up to ½, 2 or 2¼ inches, depending on which of three sizes is furnished. These three tools are fitted with Nos. 3, 4 and 4 Morse taper sockets, respectively. The smallest one weighs 63 pounds and the largest 86. Twenty feet of cable are provided, the leads entering one of the handles. A quarter turn of the latter starts and stops the machine. The motor, in common with all others in this line of portable tools, is air-cooled, and can be kept under

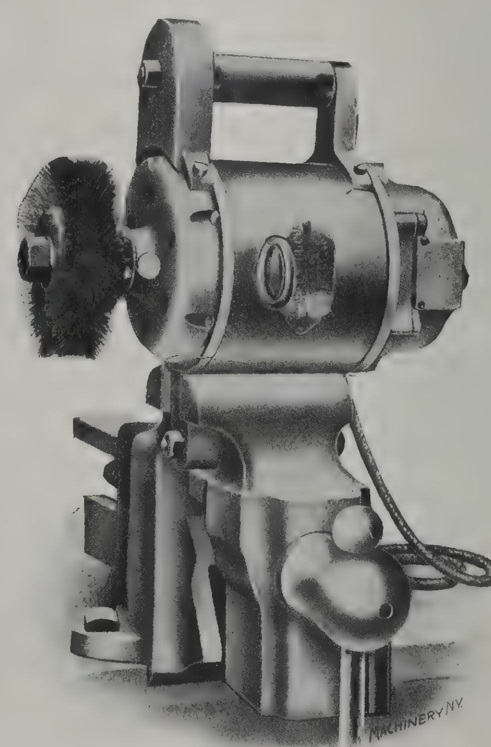


Fig. 4. A Light Aerial Grinder held in the Vise and used for Buffing and Polishing

heavy duty all day without getting heated. A fan mounted directly on the armature shaft provides the circulation for this.

The grinder shown in Fig. 3 is particularly adapted for smoothing off heavy castings. It is known as an "aerial" grinder, being hung on a spring suspension from the ceiling. The two handles hold it on the line of the center of gravity, and make manipulation of the tool easy. This direct current grinder is made in two sizes, for wheels 8 by ¾ inch and 10 by 1 inch respectively; it is furnished for alternating as well as for direct current.

Fig. 4 shows another type of aerial or portable grinder for lighter work than that done by the tool shown in Fig. 3. Here, however, the grinder has been caught in the vise, so as to make of itself a convenient bench buffing or polishing lathe. The starting switch is controlled by the knurled handle, a quarter turn of which serves to start or stop the machine.

One of the various lathe grinding attachments is shown in Fig. 5, where it is provided with an extension support and

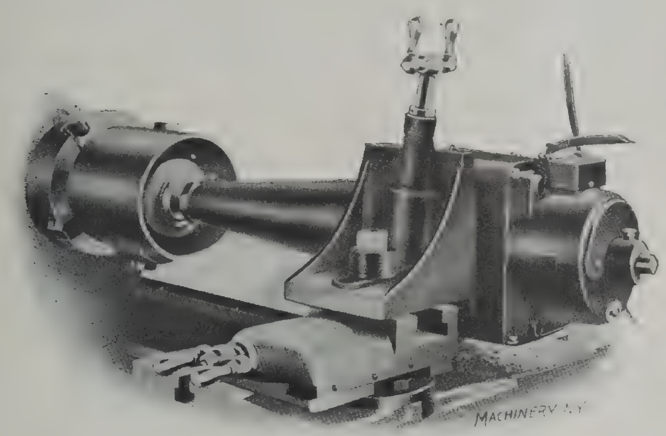


Fig. 5. Lathe Grinding Attachment, with Extended Spindle for Internal Work

spindle, particularly adapted to internal grinding. The use of such a device will bring the ordinary engine lathe into strong competition with the special grinding machine for toolroom and similar occasional work.

The various motor-driven tools just described are wound, as mentioned, for either direct or alternating current, and will be furnished for special voltages and cycles as may be required by the purchaser.

JARVIS DRAW-IN ECCENTRIC COLLET CHUCK

The accompanying half-tone shows an interesting device known as the Jarvis draw-in collet chuck, placed on the market by the Chandler & Farquhar Co., 34 to 38 Federal St., Boston, Mass. The chuck consists of a casing made in two parts, *A* and *B*, the upper part being graduated on the top surface. This casing is recessed eccentrically on the inside, and contains a cylindrical part on which worm-wheel teeth are gashed, this cylindrical part fitting in the eccentric recess of the casing, and being provided with an eccentric stem which is central with the casing when in the zero position, and into which fits

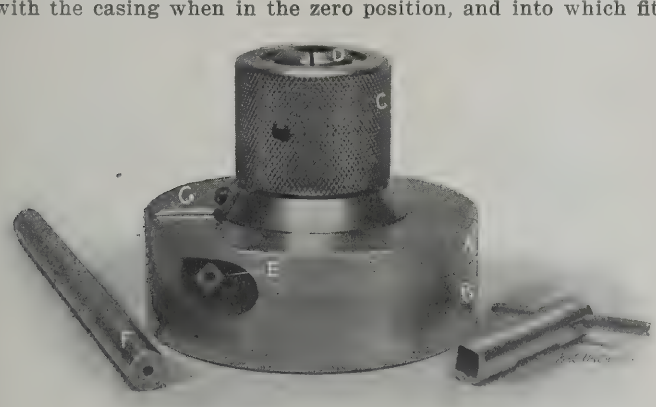


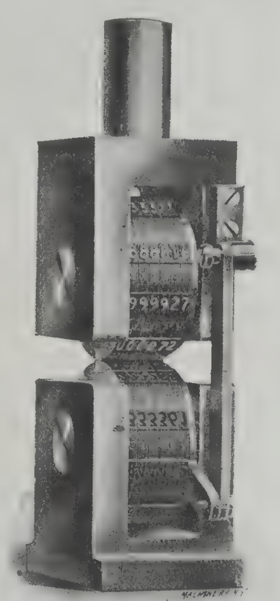
Fig. 1. Jarvis Draw-in Collet Chuck, placed on the market by Chandler & Farquhar Co., Boston, Mass.

the collet *D*. The stem is threaded on the outside, and over it fits the chuck closer *C*. The worm teeth on the eccentric disk, fitted inside the casing, mesh with a worm *E*. It is obvious that when the worm is revolved by means of a socket wrench being applied to its square head, the eccentric disk inside the casing will revolve, and will, in turn, move the collet chuck out of its true center.

The chuck will be found useful for many purposes. It can be placed either on the lathe face-plate or in a holder, and can be used for holding either the work or boring tools. It can also be used on a milling machine, grinder, or any other machine where its special features would be advantageous. It has an eccentric throw of ¼ inch from the center, and the face is graduated to read to 0.001 inch, so that it is easy to determine how much the center of the chuck will be out of its true center when the eccentric worm-gear has been turned a certain amount. A special test bar *F* is provided to be placed in the chuck in order to test when it is running true. It should, of course, be clamped to the face-plate of the lathe so that it runs absolutely true when the pointer *G* is at the zero position. If this is the case, the test bar can be removed, the work put into the chuck, the chuck moved out of center by turning the worm, and returned to an accurately central position by merely returning the pointer to the zero position. This feature will be found useful for drilling, boring or grinding eccentric bushings, or making eccentric cams. It is also useful when boring holes to size, as the boring tool can be placed in the chuck and the amount that the boring tool is fed into the work can be read off on the graduations on the face of the casing *A*. It will be found very convenient when boring jigs and fixtures in the milling machine. The chuck collets furnished have a capacity of from 1/16 inch to 1/2 inch, varying by 64ths or 32ds, as required.

BATES METAL NUMBERING MACHINE

The accompanying illustration shows one of the many types of numbering machines made by the Bates Numbering Machine Co., 696-710 Jamaica Ave., Brooklyn, N. Y. This machine is designed for embossing numbers on soft metal tags, strips, etc. The machine is operated in a power press, the upper part of it, of course, being attached to the plunger, and the lower part to the die block. It consists, as shown, of male and female dies, and can be made with 5, 6, 7 and 8 wheels, according to the number of figures required. When at work, it will number the work consecutively and automatically, there being a connecting pitman or link, as shown, between the upper and lower dies, so that they will index simultaneously. The height of the figures provided can be made either 3/16, 1/4, 3/8 or 1/2 inch, and intermediate sizes between these can be furnished if desired. The machine is an interesting example of the development of automatic numbering machines for embossing numbers on metal.



Bates Numbering Machine for Embossing Numbers on Metal

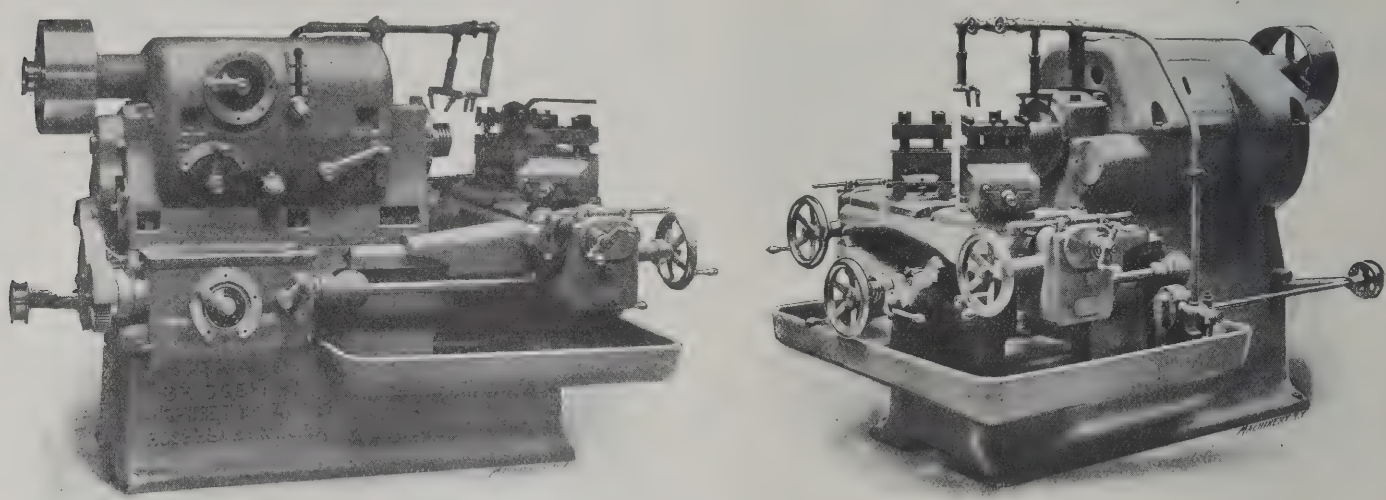
BRIDGEFORD BEVEL GEAR TURNING LATHE

In the accompanying illustrations Figs. 1 and 2 are shown front and rear views and in Fig. 3, end view, of a lathe for turning bevel gears, which has just been placed on the market by the Bridgeford Machine Tool Works, Rochester, N. Y. This machine has been designed specifically for turning simultaneously the face, front and back angles of bevel pinions and gears up to 18 inches in diameter. Besides these turning operations, the boring and the facing of the back of the gears is also done advantageously in the machine.

As will be seen from the illustrations, the frame, oil pan and oil reservoir are cast in one piece. The top of the frame or bed is provided with ways similar to those on engine lathes, and the head-stock of the machine is of a design similar to that used on the Bridgeford heavy duty geared head engine lathe, which was illustrated and described in the March, 1908, issue of Machinery, in the department of New Machinery and Tools. The drive to the geared head is through a constant speed pulley, 15 inches in diameter, as shown, with a width for a 6-inch belt and running at 440 revolu-

tions per minute. The gearing in the head provides for twelve spindle speeds ranging from 5.8 to 214 revolutions per minute. The design gives sufficient pulling power to enable three cutting tools to be used simultaneously, all cutting up to their full capacity. All the gears within the head are made of steel and run in oil. The bearings are self-oiling to prevent accidental heating and frictional losses.

The carriage is similar to that provided on a lathe, but is of a duplex construction, having an apron both in the front and in the rear of the machine, and is provided with two cross-slides carrying the angle turning rests, the right-hand cross-slide having a turret tool-holder. The carriage cross-slides and angle rests have power feed and automatic stops. The required hand-wheels are arranged within easy reach of the operator when in a working position. The machine is provided with a feed box as shown in Fig. 1, which gives ten feeds ranging from 0.005 to 0.190 inch per revolution of the spindle. The gears in this feed box are also made of steel and run in oil. From the feed box the power is transmitted by splined shafts to the aprons, the same as in a lathe, the power being carried to the rear of the machine by means of bevel gearing and a shaft which passes through the frame or bed. The machine is provided with an oil pump as shown in Fig. 2, and with properly arranged piping for carrying lubricant to the cutting tools. The oil pump is driven by a belt from a pulley on the end of the main driving shaft, as shown. All gearing has been carefully covered by suitable guards, and the machine offers a pleasing appearance on account of its well proportioned and uniform lines. The total net weight of the machine is 7,300 pounds.



Figs. 1 and 2. Front and Rear Views of Bevel Gear Turning Lathe, built by the Bridgeford Machine Tool Works

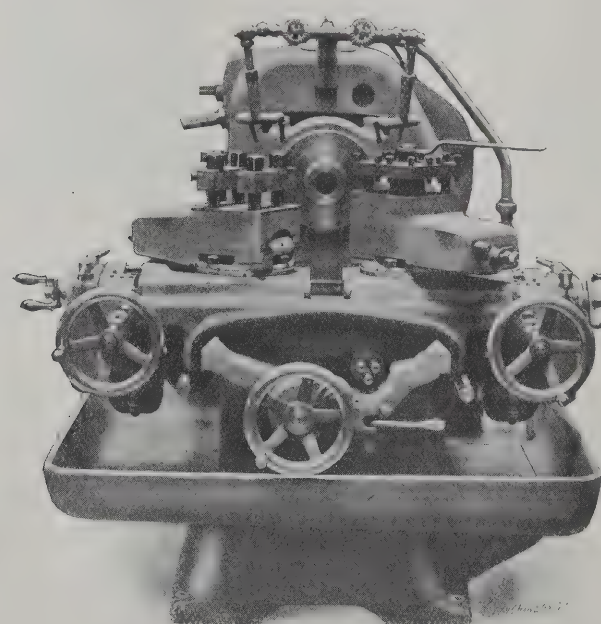
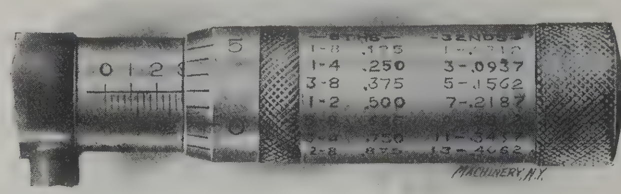


Fig. 3. End View of Bevel Gear Turning Machine

The operation of the machine will undoubtedly be of interest. The first operation consists of boring the hole and facing the back of the gear. During this operation the blank is held in a universal chuck and the hole is bored out with the tool held in the left-hand rest, while the facing is done with tools held in the turret of the right-hand cross-slide. The second operation, consisting of turning the face, front and back angles, is the one where the prominent features of the machine come more particularly into play. During this operation the blank is either held on a special hub or on an arbor in the taper hole in the spindle, which is provided with a split bushing. The left-hand turning rest carries a roughing and a finishing tool for the face angle, and the turret on the right-hand cross-slide a set of roughing and finishing tools for the front and back angles. As these tools work simultaneously, bevel gears can be finished very rapidly. Two of the machines are already in operation in a gear manufacturing plant, and have made it possible to save considerable time over that required when turning the gears with ordinary engine lathe and turret lathe methods. At the same time, more accurate work can be produced than can be done with forming tools.

DECIMAL EQUIVALENTS ON THIMBLE OF MICROMETER CALIPER

The accompanying illustration shows an improved thimble of the micrometer caliper manufactured by the J. F. Slocomb Co., Providence, R. I. The improvement consists of a complete table of decimal equivalents of eighths, sixteenths and thirty-seconds of an inch, rolled on the thimble. It should prove very handy to the machinist to have the decimal equivalents directly on the thimble, it being possible to make the figures large and distinct and easy to find and read.



Thimble of Slocomb Micrometer, with Decimal Equivalents

* * *

The seventy-fifth meeting of the British Association for the Advancement of Science was opened August 25 in Winnipeg, Canada, with 600 delegates present from the United Kingdom, the United States and Canada. The twelve sections of the association remained in session for a week. One of the principal addresses, dealing with a variety of matter of interest to scientists and scientific educators, was delivered by Sir J. J. Thompson, the president of the association.

NEW MACHINERY AND TOOLS NOTES

ADJUSTABLE WORK CLAMP: Howell & Murray, Waverly, N. Y. This is a convenient tool of simple construction for holding work on the drilling machine table. The clamp jaw is adjusted and held in position by notches on an upright which is held down to the work and table by a bolt and nut, the bolt having a square head fitting in the T-slot of the table.

HIGH-SPEED STEEL TWIST DRILL: New Process Twist Drill Co., Taunton, Mass. This drill, known as the Reliance high-speed twist drill, is made from flat bar stock twisted while hot. The twisted blade is then inserted into the tool shank, and brazed to the shank, so that the drill when finished is practically as strong as if made from one piece of steel.

AUTOMATIC SCREW MACHINE: L. Wollstein & Co., 16 John St., New York City. This machine is adapted for making small screws and other parts commonly made in automatic screw machines. Instead of a turret, however, it carries a sliding spindle for holding a drill or other tool. When external threading is to be done the spindle can be removed and an opening die of special construction put in its place.

SMALL GEAR HOBBING MACHINE: Schuchardt & Schütte, 90 West St., New York City. This machine has been designed in response to the demand for a machine to cut small gears for water meters, clocks, etc. It has a capacity for hobbing gears up to 24 diametral pitch, with an outside diameter of 4 inches and a face of 6 inches. The cutter spindle runs at 600 revolutions per minute. The machine is entirely automatic, but hand feed can be used if desired when cutting small worm gears.

RING OILING BUSHING: Brown Engineering Co., 123 North 3rd St., Reading, Pa. This ring oiling bushing for loose pulleys and clutches is particularly adapted for use in machine shops. It will run from four to six weeks without having its oil supply replenished, and it is claimed that the bushing will save over 75 per cent of the oil ordinarily required. It can be operated at speeds as high as 2,000 revolutions per minute. The bushings are made with all the standard bores from 1 3/16 inch to 2 15/16 inches.

OIL CUP: United States Metallic Packing Co., Philadelphia, Pa. This accessory has been designed with a view of making an oil cup of maximum strength. The shank of the oil cup is of machine steel, and the cover is of pressed steel, attached to the body of the oil cup by a steel chain so as to prevent losing it. It is furnished either with a needle or wick feed, and with shanks of any desired diameter and number of threads. The standard cup, however, has a ¾-inch diameter shank and 14 threads per inch.

UNIVERSAL BALL BEARINGS FOR SHAFTING: United Bearings Co., Bradford, Pa. These ball bearings are adapted for heavy loads and allow an end movement of the bearing. They consist of an outer casing proportioned to fit any standard hanger and containing a hardened and ground steel case at each end for receiving the ball bearings. The inner ball race is of hardened steel provided with a lining of good anti-friction metal fitting over the shaft. Thus the bearing is in fact a combination plain and ball bearing, so that if the ball bearing should be subjected to injury the bearing still is serviceable as a plain bearing.

BENCH CUTTING-OFF SAW: Taylor-Shantz Co., Rochester, N. Y. This machine is intended to be placed on a bench or stand, and to do the work, generally, of a power hack-saw. It is designed particularly for tool-room use. Due to the fact that a blade with a thickness of only 3/64 inch is used, considerable material is saved, which is important when cutting up high-speed steel or other expensive stock. On large work a saw 5/64-inch thick may be used. The machine weighs 160 pounds and occupies a space of 14 by 14 inches. It has a capacity for cutting off 2½ inches square, 2¾ inches round, and 4 by 2 or 4½ by 1 inch flat stock.

HEAVY SWAGING MACHINE: Langelier Mfg. Co., Providence, R. I. This machine is adapted for tapering heavy work. It swages solid stock up to 2 inches in diameter and tubing up to 3 inches, and is especially intended to meet the requirements of manufacturers of heavy tubing for the automobile trade. The machine takes dies from 4 to 8 inches long; the spindle is of large proportions, its head being 10⅝ inches in diameter by 10⅝ inches long and the bearing part 6 inches in diameter by 23 inches long. The machine should run at a speed of 240 revolutions per minute and be connected to the counter-shaft by a 7-inch belt. The floor space required is 42 by 48 inches.

SAW TABLE: Silver Mfg. Co., 317 Broadway, Cleveland, O. This machine is adapted for small pattern shops or woodworking shops on account of being inexpensive and simple. It is equipped with a safety guard and pivoted auxiliary frame for vertical adjustment of the saw, and while adapted for fine accurate work, it is amply strong enough for rough and heavy work as well. The saw is 12 inches in diameter, and when raised projects three inches above the table. Saws up to 14 inches in diameter can be used. The ripping fence tilts to any angle up to 45 degrees. The floor space of the machine is 41 by 66 inches, the size of the table 31 by 38 inches, and the height 32 inches.

UNDER-BELTED DISK GRINDER: Gardner Machine Co., Beloit, Wis. The improvement in this grinder over the Gardner grinder illustrated and described in the July, 1908, issue of MACHINERY, consists mainly in the drive and a slight modification of the frame, so that the belt can be passed over the machine spindle pulley, down through the base of the machine, and through the floor to a motor mounted in the ceiling below or in the pedestal of the machine. The spindle pulley and belt are entirely enclosed so that the whole machine offers a compact substitute for the direct motor-driven disk grinder, which presents the difficulty that grinding dust is liable to get into the working parts of the motor.

DOUBLE CRANK PRESS: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is adapted for heavy cold bending, drawing and forming operations in thick sheet steel manufacture. It is particularly intended for work of large dimensions, such as automobile engine crank cases, frame members, channels, etc., and for heavy cutting and perforating. The machine is capable of exerting a safe working pressure of 800 tons. The width between the frame columns is 74 inches, and between the gibs 67 inches. The stroke of the slide is 14 inches and the distance from the bed to the slide, the stroke down and the adjustment up, 20 inches. The adjustment of the slide is 6 inches.

HARDENING FURNACES FOR HIGH-SPEED STEEL TOOLS: American Gas Furnace Co., 24 John St., New York City. These furnaces are the results of a series of experiments undertaken to determine the best means for hardening different kinds of high-speed steel tools in gas blast furnaces. Different types of furnaces have been adopted for various kinds of tools, each type being, of course, used for a considerable variety. For instance, a special furnace is made for heating reamers, drills, taps and other tools of considerable length but small diameter. Small cylindrical work is suspended by the shanks in the heating space and is removed after heating without coming in contact with the lining of the furnace or the supports, thus preventing injury to the fine cutting edges.

ELECTRIC PYROMETER: Bristol Co., Waterbury, Conn. This pyrometer is intended for high temperatures and is designed to permit quick readings. An advantage of the instrument is that its construction substitutes an inexpensive metal for the expensive platinum-rhodium for the larger part of the couple. The tips of the couple, however, are of platinum-rhodium, and may be exposed to a temperature of 3,000 degrees F. without danger of the temperature at the junctions between the tips and the remainder of the couple exceeding a safe limit. The complete instrument is portable and temperatures up to 2,500 degrees F. can be obtained in a few seconds. By using a special form of tip, the instrument can be used for measuring the temperature of hot metal surfaces.

FORTY-TON DUPLEX CHAIN BLOCK: Yale & Towne Mfg. Co., 9 Murray St., New York City. This chain block has been brought out to meet the demands of the trade for a dependable hand hoist for handling very heavy loads in cases where the installation of an electric crane or steam hoist would be out of the question. It is composed of two 20-ton units with equalizing bars at top and bottom, thus providing for a single point of suspension and a single point of attachment of the load. Provision is made for swiveling each unit at top and bottom. The hand chains are arranged to permit two, four or eight men to work effectively. When the load is larger than 40 tons, it can generally be handled by two of these hoists working together, giving a double capacity of 80 tons.

MOTOR-DRIVEN SENSITIVE DRILL: Willey Machine Co., Jeffersonville, Ind. This drill press has been built heavier than former designs, and has a square table instead of a round one as previously used. The motor is connected to the spindle by a belt and cone pulley, and three changes of speed are provided. The motor is adjustably mounted for tightening the belt, and the starting switch is placed within the motor frame, eliminating connections outside of the motor. The distance from the center of spindle to the column is 12 inches, the maximum distance between the spindle and table 38 inches, the vertical motion of the spindle 3 inches, and the size of the table 11½ inches square. The total height of the drill is 67 inches, and the weight of the machine 200 pounds. It requires a 1/3 H. P. motor.

VERTICAL KEYSEAT MILLING MACHINE: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This machine is adapted particularly for keyseating, and is built along the lines of a vertical milling machine. The spindle is mounted in a vertically adjustable saddle, so that a minimum distance of 6 inches and a maximum distance of 18 inches between the end of the spindle and the top of the table is obtainable. The spindle speeds vary from 142 to 395 revolutions per minute with the back-gears in, and from 430 tc 1,194 revolutions per minute when driving direct with the back-gears thrown out. The work-table is 11 inches wide and 40 inches long, surrounded by an oil pan. It has an automatic power feed motion of 36 inches in either direction. The feed motion is obtained by a feed box giving nine changes. The machine occupies a floor space of about 4 by 5 feet.

THREE-HEAD REAMING AND TAPPING MACHINE: Niles-Bement-Pond Co., 111 Broadway, New York City. This machine is adapted for work on cast iron T- and L-shaped pieces up to

18 inches, and steel T's and L's up to 12 inches. It is provided with three heads mounted on a T-shaped bed, and has a stationary table to which the cradles for holding the work are clamped. Each of the three heads has independent hand adjustment and drive, as well as independent power feeds suitable for reaming and tapping, the feeds obtainable being 1/32, 1/16 and 1/8 inch per revolution. The maximum distance from the center of the machine to the ends of the spindles is 26½ inches; the distance the centers of the spindles are above the work-table is 15 inches. The spindle speeds are from 3¼ to 14 revolutions per minute. The power for each head consists of a 12½ H.P. variable speed motor.

INCLINABLE ROTARY FURNACE: Rockwell Furnace Co., 26 Cortlandt St., New York City. This furnace, intended for smooth round work, has a rotating cylinder or drum lined with a standard hard refractory brick with a smooth internal surface. The furnace is capable of being inclined, and the gradual incline causes the material to feed forward. The degree of pitch may be adjusted through a hand-wheel so as to regulate the progress of the material through the furnace to the required time of heating. This automatic continuous heating provides for a uniform heat in all the pieces, none of them being likely to be overheated or not sufficiently heated, as is the case in stationary furnaces. These furnaces can be built to suit different requirements, and in sizes to handle up to 2,000 pounds of stock per hour.

UNIVERSAL BORING TOOL-HOLDER: The Robinson Tool Works, Waterbury, Conn. This tool-holder differs from other holders intended for the same purpose particularly in that it passes over the lathe tool-post instead of passing through the tool-post slot. It is clamped by means of the regular tool-post wedge and screw, the tool supporting ring or washer being removed from the tool-post. The advantages claimed in connection with this tool-holder are that it elevates the boring tool horizontally, that tools of any diameter and of any kind of round stock can be used, and that it is always possible to have the tool projecting the right length from the holder. It is made in five sizes, the smallest size adapted to a No. 1 watchmaker's lathe, and the largest to lathes having 20 to 36 inches swing and taking boring bars to 1¼ inch in diameter.

VARIABLE SPEED COUNTER-SHAFT: Hawkeye Mfg. Co., Cedar Rapids, Ia. This device depends for the variations of speed on the greater or less amount of slipping in the frictional contact between the constant speed driving pulley and the shoes of a spider carrying the driven pulley. It is claimed that uniform speeds are obtained, due to the fact that the principle of the centrifugal governor is introduced in the mechanism. The essential parts of the device are driven pulley and a friction clutch of the drum and brakeshoe type, having an adjustable contact controlled by a lever, or a sheave with drop chain, with which the pressure of the shoes on the wheel face can be regulated. Not only the cone pulley, but also the tight and loose pulleys, are eliminated from the drive. A continuous range of speeds from the maximum to the minimum is obtainable.

SURFACE AND TOOL GRINDER: Robinson Tool Works, Waterbury, Conn. This grinder has been designed for grinding the faces of small dies and punches and for surface grinding of other small parts occurring in tool work. It can also be used as a regular tool grinder, and is provided with holders for grinding twist drills and milling cutters. It consists of a head carrying two wheels, one at each end. A table or platen is provided under one of the wheels. The other wheel is provided with an adjustable tool-rest and a fixture for holding twist drills, this latter having a capacity for drills from ⅛ inch up to 1½ inch diameter. The machine is either adjustably mounted on a column or furnished as a bench grinder. The diameter of the surface grinding wheel is 5 inches and of the drill grinding wheel 6 inches. The net weight of the machine, including counter-shaft, is 180 pounds.

RIVET SPINNING MACHINES: Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. Three new riveting machines have been brought out by this company, two being riveters of the noiseless type equipped with flat and horn tables, and designed for work requiring a great depth of throat; work 11½ inches from the edge can be riveted. On the riveter provided with a flat table, fixtures can be mounted for different classes of work. The machine with the horn table is especially adapted for the manufacture of railroad lamps, signal lamps, metallic doors, etc. A small double spindle riveting machine for rivets ⅛ inch in diameter and less and adapted for light work such as small hinges, jewelry novelties, etc., has also been brought out. It heads simultaneously both ends of a plain wire passing through the work. This machine may be mounted on a bench or pedestal and is operated by a treadle attached to the floor. The maximum capacity between the spindles is 1½ inch.

HIGH-SPEED DRILLING AND TAPPING MACHINE: Cincinnati-Bickford Tool Co., Cincinnati, O. This machine has been designed to meet the requirements of a high-speed and high-powered machine, particularly adapted for high-speed steel twist drills. It is also provided with a slow speed for tapping and with a quick return for withdrawing the tap. It is of the upright type, motor or belt driven as required, and provided with special bracing in the back of the column to provide additional strength. The head is vertically adjustable on the column; the spindle is provided with ball bearings, and jam nuts for adjustment, and an automatic stop so that a number of holes may be drilled to a given depth. A geared feed box is located on the sliding head and provides for six feeds varying from 0.006 to 0.039 inch per revolution of the spindle. The lever for manipulating the back gear when placed in a neutral position will stop the spindle. The machine is provided with gear box drive when belt driven, but in the variable speed motor driven machine the motor takes the place of the gear box. The gear box provides for 18 different speeds, giving, in connection with the back-gears, 36 spindle speeds varying from 38 to 534 revolutions per minute. The machine is provided with the company's patented geared tapping attachment, and a high-speed attachment, desirable for drilling small holes, may also be used in connection with this drill. The machine is built in sizes from 24 to 42 inches.

* * *

THE SALE OF THE IRON AGE

The sale of the *Iron Age*, the formal transfer of which was made the latter part of September, transfers to new owners the oldest and best-known trade publication in this country. The publication will be continued by the David Williams Company, with Charles T. Root, President, Charles Kirchhoff, Vice-President, and W. H. Taylor, Secretary and Treasurer.

In his valedictory, which is given the leading editorial place in the last number, Mr. Williams says:

The conductors of *The Iron Age* have always felt their responsibility as publishers of an organ of important information to which the trade looked for impartiality and fairness. Its reputation (even in other hands) is dear to us, and on no account would we have entertained a proposition to allow the paper to get into the hands of men whose ideals of journalism were not high. Fortunately this is not the case here. The purchasers are men of standing and eminently qualified for the task they have undertaken. I have known Mr. Root for many years, and entertain for him a profound respect and regard, not only as a peculiarly able publisher, but as a charming and high-minded man. His associates are publishers of character, experience and skill. I feel that *The Iron Age* is safe in their hands and wish them all possible prosperity and success.

The opinion Mr. Williams holds of the gentlemen who now control the *Iron Age* is shared by all who know them, and especially by trade paper publishers whose knowledge is more intimate and personal. Under their management the *Iron Age* will undoubtedly advance along new and aggressive lines, to even greater prosperity than it attained under its former owners.

* * *

WORCESTER TRADE SCHOOL

Plans for the proposed Worcester trade school have been prepared by the architects, and submitted for consideration. The academic building has a frontage on Grove St. of 200 feet and runs south on Concord St. to Prescott St. It is to be built of brick with limestone trimmings and the estimated cost is $275,000. Fronting on Grove St., is the academic section of the wing, 57 feet by 52 feet, three stories and basement. Attached to the academic section and fronting on Concord St. is the shop, 214 feet long and 42 feet wide, two stories and basement. The first and second floors of the academic section will be occupied as class rooms, and on the third floor is a large drafting room. The basement and first story of the shop section will be given up to the machine shop and the second floor will be devoted to the wood-working department. At the south end of the shop, fronting on Prescott St., will be the power plant in the basement and on the opposite side is the blacksmith shop. The moulding room will be on the first floor under these departments. A department for bookkeeping and cost accounting is provided for, where the pupils will be taught the cost of production. The wing about to be constructed will accommodate about 300 boys, and the estimated cost is from $50,000 to $60,000.

* * *

The central idea that the boy gets at college is training, training of the mind, storing the mind full of things. Now I say, without the slightest hesitation, that for success in life, intellectual training comes second or third. Without question, character comes first; good sense, second; and intellectual training, third.—*F. W. Taylor.*

THE VERNAZ CIRCULAR CUT FILE*

The Vernaz file has been previously illustrated and a general description presented in the March, 1907, and the September, 1908, issues of MACHINERY. In the latter of these issues it was referred to as the "Vixen" file, this name being the American trade name. The file is the result of an effort on the part of Mr. Alexis Vernaz of Yverdon, Switzerland, to save from the scrap heap a large number of accidentally hard castings. Proving itself successful, it was patented in nearly all industrial countries. The most prominent feature of the file, apparent to the casual observer, is that the teeth of the file are cut circular as shown in Fig. 1.

The essential feature of the Vernaz file, outside of the circular cut, is the form of the tooth itself, the section of the teeth being similar to that of the teeth in a milling cutter. The included angle of the teeth is 60 degrees, with a front rake of 1½ degree. The number of teeth per inch varies from 6 2/3 to 16, according to the purpose for which the file is intended. The teeth are cut one at a time with an end mill made in the shape of a hollow cylinder, having a diameter of from 2½ to 3 inches, and the edge beveled off to an angle of 60 degrees. This end mill is set at an angle of 1½ degree with a line at right angles to the plane of the file. In the manufacture of the files, automatic machines rotate the cutters, feed them into the file blanks to the proper depth, withdraw them, index or move the file the length of the pitch, and then repeat the same action for the next tooth.

At first it would seem that the inclination of the axis of the cutter would produce a cutting edge on the file which would not be flat, but concave. This, of course, is true of the bottom of the cut, but the shape of the top or edge, being produced by the intersection of the conical (beveled) face of the cutter with the cylindrical surface made by the preceding cut, is rather doubtful at first sight. In Fig. 2 the true shape of the edge has been determined by drawing it in a scale several times the true size. In this illustration lines *C* and *D* are corresponding elements of the cylindrical and conical surfaces of the tooth at the edge of the file, and determine the corner *A* of the tooth. The point *A* at the outer edge of the file falls distinctly below the surface of the blank. The top of the file, consequently, is very slightly convex, which is probably an advantage. The convexity is very slight, amounting to only about 0.002 inch on a file 1¼ inch wide.

It has been found that the circular cutting edges cut properly whether the file is pushed straight or at an angle, and also that the relatively large pitch and depth of teeth pre-

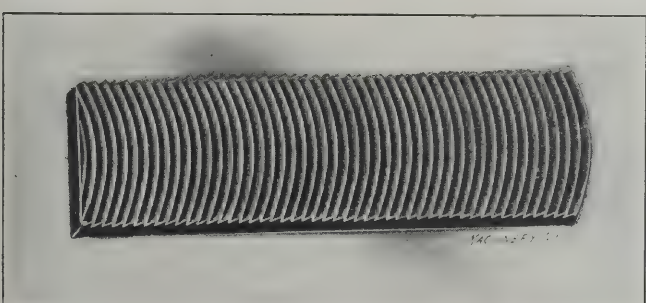


Fig. 1. A Section of the Vernaz File, known in the United States as the "Vixen" File

vent clogging and the necessity of cleaning, and produce exceptionally smooth surfaces. The surface produced on steel is smoother than that from an ordinary second-cut file, due to the fact that the latter has a tendency to retain small chips between the teeth which scratch the surface filed. On fibrous and tenacious materials, such as wrought iron, mild steel, brass and aluminum, the improvement over ordinary files is very marked. That the action is a cutting one and not an abrading or grinding action, is shown by the chips, which under the magnifying glass are curled up and look as if they were made by a lathe or planer tool.

Tests have been undertaken on these files at the works of Wm. Sellers & Co., Inc., and by Tinius Olsen & Co., Philadelphia, Pa., using a file-testing machine built by Edward G. Herbert, Ltd., of Manchester, England. (This machine was described in the December, 1907, issue of MACHINERY, engineering edition, and also referred to in the September, 1909, issue of MACHINERY, engineering edition, in an article entitled "The Testing of Files and Tool Steel." In making comparative tests of twenty-nine files from eleven different makers, it was found that twenty-eight out of the twenty-nine regular commercial files, when tested on cast iron, removed from 0.7 to 20.6 cubic inches, while only one file removed 73 cubic inches. These tests also bore out the results of experiments made by Edward G. Herbert himself, showing that the two sides of a file often show extreme variation in cutting capacity. In the tests referred to, the worst case of this kind was a file which

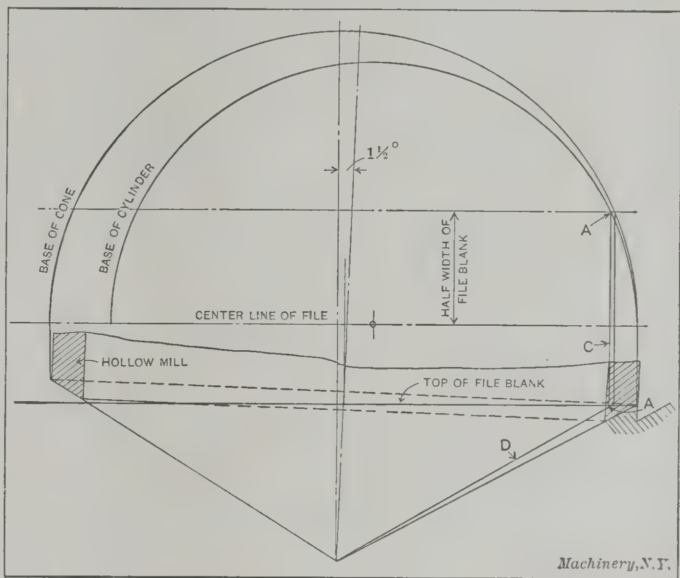


Fig. 2. Diagram used for showing that the Top Surface of the Vernaz File is Convex

removed 20.6 cubic inches by one side and 0.4 cubic inch by the other. Four Vernaz files have been tested on cast iron. The poorest one removed a total of 48.2 cubic inches, using both sides, and the best 143.75 cubic inches, the variations between the two sides being very slight, the worst case being a file removing 49.1 cubic inches by the one side and 34.9 by the other. On high carbon steel the minimum and maximum figures for ordinary commercial files were 3.6 and 6.4 cubic inches, and for the Vernaz files 9 and 25.8 cubic inches. In this case, however, two out of three Vernaz files showed a marked difference on the two sides.

The committee of the Franklin Institute reporting on the Vernaz file considers that this invention is the first radical improvement in files for generations, and that the inventor has done the industrial world a marked service, not only in presenting a new and efficient cutting tool for metals, but also in the impetus which the introduction of the tool will give to improvement in cutting capacity and endurance of the regular type of files. The committee, therefore, recommended that the inventor be awarded the Elliott Cresson medal as an appreciation of his achievement.

* * *

Santos-Dumont, the Brazilian aviator who attracted the attention of the world to himself some years ago by his dirigible balloon experiments and exploits, lately built an aeroplane of diminutive size that flew at a speed of fifty-five miles an hour near Paris, September 14. It weighs together with pilot only 260 pounds, and has only nine square yards of wing surface as against twenty-two square yards in the Curtiss aeroplane, twenty-six square yards in the Bleriot machine and fifty-three square yards in the Wright machine. The motor is a two-cylinder gas engine developing 30 horsepower at 1,800 R. P. M. The machine, which is of the butterfly type, is so constructed that it can be used both as an aeroplane and a motor car, rising at will from the road, and descending again to run on the ground. Santos-Dumont expects to reduce the distance required to rise to about forty or fifty yards. The trials at St. Cyr required only seventy to eighty yards to start.

* Abstract of a report of the Franklin Institute, through its Committee on Science and the Arts, published in the *Journal of the Franklin Institute,* September, 1909.

PERSONAL

Charles S. McCarthy has taken the position of superintendent with the Warner Mfg. Co., Toledo, O.

O. J. Sundstrand has been elected secretary and treasurer of the newly-organized National Machine & Tool Works, Rockford, Ill.

William M. Grove has been given full charge of the Cleveland territory for the product of the Ingersoll Milling Machine Co., Rockford, Ill.

T. F. Meek, for twenty-one years with the Detroit Steel Casting Co., is now vice-president and general manager of the Toledo Steel Casting Co., Toledo, O.

C. C. Wais of the C. C. Wais Machine Co., Cincinnati, Ohio, has sold his business, and is now connected with the Covington Machine Co., Covington, Va.

F. G. Kernan, formerly Eastern sales agent for the Fox Machine Co., Grand Rapids, Mich., has been made general sales manager of the company, with headquarters at Grand Rapids.

M. T. Lanse has been made secretary and treasurer of the Foglesong Machine Co., Dayton, Ohio, succeeding A. C. Jackson, who is now cashier of the North Dayton Savings Bank.

Henry Bowman, formerly with the Detroit Steel Casting Company, has taken the position of superintendent of the Toledo Steel Casting Co., which firm succeeds the C. E. Sutton Company.

Perley E. Harvey, who recently resigned from the position of assistant superintendent at the Chapman Valve Mfg. Co., Springfield, Mass., has taken a position with the Fore River Ship Building Co., Quincy, Mass.

W. S. Chase, sales manager of the National-Acme Mfg. Co., Cleveland, Ohio, sailed September 11 for a two months' business trip in Great Britain and on the Continent. He was accompanied by his wife.

Frank Salomon, representative of the engineering staff of Alfred Schütte, Cologne, Germany, is on a visit to America in the interests of his house. His American address is Alfred H. Schütte, 90 West St., New York.

The name of the heating and ventilating engineer of New York, referred to in the article by Mr. C. M. Ripley, "Pure Air Law for Workmen" in the September number, engineering edition, is Percival Robert Moses.

Edwin Cedarleaf, formerly superintendent of the Rockford Machine & Shuttle Co., is now general manager of the National Machine & Tool Works, a concern which succeeds to the old Dalin Bros.' shop and business in Rockford, Ill.

Adolph W. Gilbert has been elected president and general manager of the Chapman Valve Mfg. Co., Springfield, Mass. Mr. Gilbert recently resigned from the position of general manager with the Pratt & Cady Co., Hartford, Conn.

Charles M. Robertson, superintendent of the Colburn Machine Tool Co., Franklin, Pa., resigned his position September 1 to become a salesman with the E. L. Essley Machinery Co., of Chicago and Milwaukee, agent for the Colburn boring mill.

T. W. Warner has been elected president and general manager, and E. S. Janney, secretary-treasurer of the newly organized Warner Mfg. Co., maker of automobile gears and transmissions, which occupies a part of the old Pope plant in Toledo, Ohio.

Frank H. Hill, formerly in the sales and engineering departments of the New York office of the Sprague Electric Co., has been made manager of the Atlanta, Ga., branch office, and assumed his new duties September 1. Mr. Hill succeeds Mr. F. V. L. Smith, resigned.

P. P. H. Conover, secretary and treasurer of the Miami Valley Machine Tool Co., Dayton, Ohio, returned in September from a two months' trip in Europe. He visited England, France, Germany, Italy and Switzerland. The trip was partly on business and partly for pleasure.

P. T. Wingo, for twenty-two years with the Brown & Sharpe Mfg. Co., Providence, R. I., on work relating to gearing and special machinery, has resigned and is now connected with the Cadillac Motor Car Co., Detroit, Mich., in a general mechanical engineering capacity.

A. W. Lewin was advanced September 1 to the position of manager of the New Orleans office of the Sprague Electric Co., New York. Mr. Lewin is a member of the American Institute of Electrical Engineers, and has had extensive commercial and engineering experience in the electrical business in both North and South America.

James H. Norris, for the past nine years business manager of the John F. Allen Riveting Machine Co., 370-372 Gerard Avenue, New York City, resigned his position, his resignation having taken effect September 1. It was Mr. Norris' intention to take a rest of about two months, part of which time was to be spent on an extended trip.

P. J. Hoenschied, for several years vice-president and mechanical manager of the National Twist Drill & Tool Co., Detroit, Mich., has disposed of his interests in that concern and expects to start a new company for the manufacture of automobile parts. The Hoenschied stock was purchased by members of the National Twist Drill & Tool Co.

C. E. Wust, of C. E. Wust & Co., Seebach, Zurich, Switzerland, is in America to establish licensees for making the Wust herringbone gearing (see MACHINERY, engineering edition, April, 1908, page 515) and to make a contract with some maker of American machine tools to build the Wust herringbone gear-cutting machine. The Grand Union Hotel, New York, is his headquarters.

M. M. Shepherd has just been appointed shop instructor at the James Millikin University, Decatur, Illinois. Mr. Shepherd has had wide experience both as a mechanic and as an instructor in designing, drafting, pattern-making, forging, foundry and shop work. He was for three years teacher of manual training in the city schools of Providence, R. I., and four years in similar work in the high schools of Milwaukee, Wis.

F. H. Banbury, engineer of the Acheson-Oildag Co., Niagara Falls, N. Y., sailed for Europe on the steamship *St. Louis*, September 25. Mr. Banbury is an Englishman by birth; he came to America about five years ago and became connected with the Acheson-Oildag Co. over a year ago. His European trip is taken in the interest of the company to introduce deflocculated graphite, the discovery of Edward G. Acheson, president of the company.

W. E. Wickenden has been appointed assistant professor of electrical engineering of the Massachusetts Institute of Technology, Boston, Mass., and will assume the duties vacated by Prof. G. E. Shaad, who has gone to the University of Kansas to take charge of the electrical engineering department there. Mr. Wickenden is a graduate of Dennison University, and is a member of the electrical engineering staff of the University of Wisconsin. He is the author of a book on photometry and illumination.

* * *

OBITUARIES

James Denver, formerly master car builder of the N. Y., N. H. & H. R. R., died August 19, and was buried in Springfield, Mass.

Walter E. Andrews, president of the Williams Typewriter Co., died at his home in Shelton, Conn., September 7 of arterial trouble, aged fifty-nine years. Mr. Andrews was a native of Vermont, and, when a young man, went West and resided in Des Moines, Iowa, for many years, where he became president of the Western Newspaper Union. He came East to Brooklyn and about nine years ago removed to Shelton.

Russell Markham died at the home of his son, E. R. Markham, Cambridge, Mass., August 24. Mr. Markham, during war times, worked on rifles for the United States government at the old Jones & Lamson shop, Windsor, Vt., and the Massachusetts Arms Co., Chicopee Falls, Mass. After the close of the civil war the Lamb Knitting Machine Co. bought the Massachusetts Arms Co. plant and Mr. Markham entered its employ as foreman, which position he held for nearly forty years, retiring only four years ago on account of advanced age.

Robert Hoe, 3rd, head of R. Hoe & Co., printing press builders, New York and London, died in London, September 22, aged seventy years. Mr. Hoe was the third in line of printing press builders. His grandfather, Robert Hoe, came to America from Leicestershire, England, in 1784, and in 1803 started a printing press plant with his brothers-in-law, Matthew and Peter Smith. Mr. Hoe was succeeded by his two sons, Col. Richard M. Hoe and Robert Hoe, 2nd. Robert Hoe, 3rd, was a son of the latter, and succeeded to the management in 1884. At the time that Robert Hoe, 3rd, entered the business, the cylinder press invented by his uncle, Richard M. Hoe, had a capacity of only 9,000 sheets of four pages each per hour, which had afterwards to be folded by separate machinery or by hand. Hoe presses are now built that are fed with eight rolls of paper at once, and produce 166,000 16-page newspapers per hour, folded ready for delivery. While Mr. Hoe was remarkable for his inventive capability, it is said he never took out a patent in his own name. He was an organizer of ability and systematized his factory thoroughly in all departments. Mr. Hoe also had some reputation as an author, having written several books on book-binding, evolution of printing presses, etc. He gave a great deal of attention to the education of apprentices, and every boy apprentice to R. Hoe & Co. was compelled to attend school, one hour of his working time and one hour of his own time being devoted to this purpose every week day evening. The Grand Street factory, New York, employs about 2,500 men, and the London factory about 800 men.

* * *

The Zeppelin airship has found a serious rival in the Schütte airship, which will undergo thorough trials within a few months. This navigable balloon will have a lifting capacity of five tons, and its chief interest centers in the fact that the inventor has devised means for storing the gas forced out of the balloon by the ascent into high altitudes, or by the expansion due to the heat of the sun's rays. This fact

will enormously extend the possibilities of remaining in the air, as the gas can again be supplied to the balloon as required. The plans have been submitted to leading aeronautic experts and are said to have met with their encouragement. Prof. Schütte retains the rigid frame of the Zeppelin airship but employs wood instead of aluminum, and the cover has a lining of gold-beater's skin. From these new features important advantages are anticipated. The airship will be lighter and more elastic, the loss of gas will be reduced to a minimum, and the absence of metal in the framework will render ignition from lightning less probable. At the same time, the absence of metal enables a wireless telegraphy outfit to be carried in the car without danger.

* * *

COMING EVENTS

October 3-9.—St. Louis Centennial Week, St. Louis, Mo. Balloon, airship and aeroplane races will be arranged under the auspices of the Aero Club of St. Louis.

October 4-8.—Annual joint convention of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants' Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

October 12.—Monthly evening meeting American Society of Mechanical Engineers at the Engineering Societies Building 29 West 39th St., New York. Calvin W. Rice, secretary, 29 West 39th St., New York.

October 12-13.—Semi-annual convention of the National Machine Tool Builders' Association at the Hotel Astor, New York. P. E. Montanus, secretary, Springfield, Ohio.

October 14.—MACHINERY'S seventh annual outing.

October 19-21.—Annual convention of the American Railway Bridge and Building Association, Jacksonville, Fla. S. F. Patterson, secretary, Boston & Maine R. R., Concord N. H.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Viewger, American manager, 50 Church St., New York.

December 1-13.—Annual convention of National Association for the Promotion of Industrial Education, Milwaukee, Wis. J. C. Monagham, secretary, 20 West 44th St., New York.

NEW BOOKS AND PAMPHLETS

INVENTIONS, PATENTS AND DESIGNS. By G. Croyden Marks. 116 pages, 4¾ by 7 inches. D. Van Nostrand Co., New York. Price $1.

This work contains the full text of the British patent and designs act of 1907 and will for this reason be particularly valuable to Americans who are interested in British patents. The general text treats of fostering industries, the meaning of patents, what is patentable, surrender and revocation of patents, licensing of inventions, infringement of patents, patent working in America, legal proceedings, applying for an injunction, how to work patents, designs, etc.

POCKET MANUAL OF ENGINEER'S SOLAR TRANSIT. 53 pages, 4½ by 6½ inches, 9 illustrations. Published by Keuffel & Esser Co., 127 Fulton St., New York, and Hoboken, N. J.

The manual describes the Keuffel & Esser engineer's solar transit, its adjustments and method of use. A table of mean refractions is included, also rules for taking the sun at any latitude or longitude, determining the meridian by direct observation on the sun and determining the meridian by observation on Polaris. While the manual is designed for engineers and others fully familiar with the use of the transit, it will also be found of considerable interest to amateurs and others who would like to know how the polar explorers Cook and Peary located the pole or how navigators verify their position in mid-ocean.

MACHINE SHOP DRAWING. By Fred H. Colvin. 139 pages, 4¼ by 6¾ inches, 91 illustrations. Published by the McGraw-Hill Book Co., New York. Price, $1 net.

This book is intended to help those who do not understand the reading of drawings rather than to teach drawing itself. It is a fact that many good mechanics are "shy" on reading blue-prints, and this treatment of the subject has been with a view of explaining to this class the principles of mechanical drawing, illustrating the same with examples of common objects found in machine shop practice. The contents by chapters are: Reading Drawings, Drawing of a Monkey Wrench, Some Examples of Drawings, Laying Out Spur Gears, Laying Out Bevel Gears, The Worm and Worm-wheel, and Sketching.

HENDRICKS COMMERCIAL REGISTER OF THE UNITED STATES FOR BUYERS AND SELLERS. 1,220 pages, 7½ by 10 inches. Published by S. E. Hendricks & Co., 74 Lafayette St., New York. Price $10, express charges prepaid.

This well-known directory of the architectural, mechanical, engineering, electrical, construction, railroad, iron, steel, mining, mill, quarrying, exporting and kindred industries has passed into the eighteenth edition. It contains over 350,000 names and addresses and has 35,774 classifications, fully listing manufacturers and dealers in the industries mentioned. The comprehensiveness of the directory may be inferred from the statement made by the publishers that it lists for railroads everything from a track bolt to a locomotive; for mining, everything from a miner's lamp to a stamp mill of steel tipple; for the machine shop, everything from a tool-holder to a boring and turning mill or traveling crane; for foundries, everything from a molder's flask to a cupola; for contractors, everything from a pick or shovel to a hoisting engine or steam shovel; for the drafting room, everything from a drawing pencil to a blue-printing machine; for power transmission, everything from a belt fastener to a complete system including the latest specialties in right angle transmission and variable speed countershafts. The directory is one that we heartily recommend to all who desire comprehensive lists of concerns in the various industries. The lists are conveniently arranged for circularization, etc.

CATALOGUES AND CIRCULARS

FREDERICK O. DRAKE & Co., Fisher Building, Chicago, Ill. Catalogue of mechanical books for home study.

MODERN TOOL Co., Erie, Pa. Leaflet of universal grinding machines made in two sizes, 9 x 26 inches and 13 x 32 inches capacity, respectively.

AMERICAN RAILWAY STEEL TIE Co., Harrisburg, Pa. Circular describing the composite steel and asphalt filling tie made under the John G. Snyder patents.

PHILLIPS PRESSED STEEL PULLEY WORKS, 4th St. and Glenwood Ave., Philadelphia, Pa. Leaflet illustrating the Elliott Cresson medal awarded to Ferdinand Phillips, October 2, 1907, for his machinery for manufacturing pressed steel pulleys.

WELLS BROS. Co., Greenfield, Mass. Circular of machine screw taps and dies of the American Society of Mechanical Engineers standard. The A. S. M. E. sizes are being adopted by many manufacturers, and it is probably only a matter of a few years when the V-thread machine screws will become obsolete.

FRANK MOSSBERG Co., Attleboro, Mass. Five full size illustrations of Mossberg screw wrenches, namely: Midget, Sterling No. 2, Sterling No. 3, Sterling No. 14, and Sterling No. 50. The half-tones reproduce the beautiful mottled effect of case-hardening and are very attractive examples of half-tone illustrations.

ELECTRICAL ALLOY Co., Morristown, N. J. Catalogue No. 2 of resistance materials in every variety of wire, sheet and ribbon, nickel steel alloy, nickel copper alloy, ferro-nickel alloy, nickel-chromium alloy, German silver alloy, for use in the manufacture of arc lamps, resistance controllers, car heaters, measuring instruments, rheostats, etc.

CLEVELAND TWIST DRILL Co., Cleveland, Ohio. Leaflet on drill grinding, reproducing MACHINERY'S shop operation sheets Nos. 100 and 101 on grinding flat and twist drills. The company supplies a model drill point in die-cast metal which is intended to serve as a guide to the proper grinding of drills. This will be found valuable by all users of twist drills. The price is $1.

NEW ERA GAS ENGINE Co., Dayton, Ohio. Catalogue of New Era auto-cycle which is designated as a two-wheeled automobile, and is operated similarly to an automobile. It has no pedals and is driven by an air-cooled 3½ horse-power single-cylinder motor through a two-speed gear that enables the rider to ascend the steepest hills found on the ordinary highways.

KEUFFEL & ESSER Co., 127 Fulton St., New York, and Hoboken, N. J. Price list of blue-print papers which are supplied in three grades as regards time: regular, requiring from four to eight minutes' exposure in bright sunlight; quick, for work required on short notice and where no good light is available, and electric quick, for use with electric light and electric printing machines.

WESTERN ELECTRIC Co., 463 West St., New York. Bulletin of tungsten miniature low voltage incandescent lamps, 1.5 to 20 volts. These lamps vary in efficiency from 0.9 watt per candle power to 1.33 watts per candle power, and are desirable for use on automobiles, flash-lights, signs, dental, optical and surgical instruments, etc., and in fact in any place where small low-voltage power lamps are used.

MIAMI VALLEY MACHINE TOOL Co., Dayton, Ohio. Catalogue F of Miami Valley engine lathes made in 13-inch and 16-inch sizes, 13-inch stud lathes, sensitive drills, plain cutter and reamer grinders, No. 2 universal grinder with automatic feed, No. 2 universal surface grinder, No. 1 universal cutter and tool grinder. The operations of grinding a form cutter, gear cutter, blanking punch, spiral cutter, T-slot cutter, side milling cutter, etc., are illustrated.

INGERSOLL-RAND Co., 11 Broadway, New York. Bulletin No. 4009 of Temple Ingersoll "electric air" rock drills. The Temple Ingersoll "electric air" rock drill apparatus comprises an electric motor and a two-cylinder air pump and the rock drill proper. The air pump is connected with the rock drill by two hose and the pulsations of the pump work the drill in unison, using the same air continuously.

CHAPMAN ENGINEERING Co., 917 Land Title Building, Philadelphia, Pa. Catalogue of casehardened, corrugated copper flange gaskets, adapted to all kinds of steam service, working equally efficiently under superheated steam, high pressures or low pressures. These gaskets are guaranteed not to burn or blow out, to stand 500 pounds steam pressure and superheated steam of any practicable working temperature and to make an absolutely tight joint on a rough or pitted surface.

NORTON Co., Worcester, Mass. Booklet entitled "Facts Worth Knowing about Grinding Wheels," containing valuable information for users. The Norton grinding wheels are made by three processes—vitrified, silicate or semi-vitrified, and elastic, and in grades suitable to all classes of work. Suggestions for ordering are given which will be found valuable by those who are not fully aware of all the factors that enter into the selection of grinding wheels necessary to secure the highest efficiency.

NEWMAN-ANDREW Co., 107 West St., New York. Circular of "Toledo" high-speed steel manufactured by Jno. Hy. Andrew, Ltd., Toledo Steel Works, Sheffield, England. The circular gives directions for treating "Toledo" high-speed steel, ordering steel suitable for various purposes, such as cold chisels, boiler snaps, mint dies, rock drills, lathe tools, milling cutters, etc., and lists the various brands manufactured. A comparison of thermometric scales, and tables of weights of bar stock per lineal foot are appropriately included.

ELECTRO-DYNAMIC Co., Bayonne, N. J. Circulars No. 29, 32, 34 and 35, illustrating the electro-dynamic interpole variable speed motors which have the following characteristics: 1. Constant speed at any controller position regardless of load. 2. Wide speed range by field control. 3. Freedom from sparking. 4. Compactness. 5. Reversibility. 6. Operation on any single voltage—110, 210, or 500 volts. The circulars describe the theory of magnetic action and illustrate the construction of the motors, and their application to machine tools, elevators, printing presses, crane trolleys, vacuum cleaning pumps, centrifugal pumps, etc.

W. S. ROCKWELL Co., 50 Church St., New York. Circular of Rockwell annealing and hardening furnaces, giving dimensions, fuel consumption of oil and gas, and other data required by purchasers. The furnaces are made in 13 sizes, the smallest having chamber dimensions of 10 by 13½ inches, and entrance to chamber, 9 by 5 inches. The largest furnace listed has a chamber 39 by 54 inches with entrance 36 by 18 inches. These furnaces are suitable for annealing, hardening, tempering and casehardening, but are not adapted for hardening high-speed steel.

NATIONAL FILE & TOOL Co., 2110 Allegheny Ave., Philadelphia, Pa. Catalogue of the "Vixen" patent hand milling tool. The Vixen file and milling tool was described in the May, 1909, number of MACHINERY. It differs from the ordinary file in the shape of the cut, the teeth being formed on the arc of a circle and so shaped as to give a smooth shearing action. It is claimed that the Vixen file and milling tools will cut from three to five times as fast as an ordinary file tool, and last from four to six times as long. They are particularly efficient on soft metals and alloys such as babbitt, lead, aluminum, etc., cutting rapidly and being self-cleaning.

W. F. & JOHN BARNES Co., 231 Ruby St., Rockford, Ill. Catalogue No. 69 of upright drills and other machine tools, comprising bench friction disk drill, floor friction disk drill and regular upright drills of various patterns and designs from 15 inches swing to 50 inches swing, inclusive. These drills are provided with special attachments according to requirements, including gear tapping attachment, compound table, oil feeding device, multiple spindle head, etc. The Barnes horizontal radial drill is illustrated, and also the Barnes water emery grinder, adjustable screw press, universal sliding chuck attachment, and various features of design and construction of the upright drills.

TRENTON IRON CO., Trenton, N. J. Treatise on the Bleichert system of aerial tramways by W. Hewitt. Various installations of aerial tramways were illustrated and the construction of the lock coil track cable made by the Trenton Iron Co. is shown. A folder illustrates the installation at the Laurentide Pulp Co., Montreal, Canada; Smuggler Union Mine, Creede, Col.; Iowa Gold Mining & Milling Co., Silverton, Col.; United Concentration Co., Monte Cristo, Wash.; Bachelor Commodore Mining Co., Creede, Col. The pamphlet will be found of much general interest to all concerned with the problem of cheaply transporting materials in a rough country across valleys, rivers and other obstacles.

S. OBERMAYER CO., Cincinnati, Ohio, publishes a house organ known as the *Obermayer Bulletin*, which is devoted to foundry practice and matters pertaining to successful foundry management. In the September number a series of articles on foundry troubles by Mr. R. H. McDowell was begun, which promises to be of much practical value to the foundry trade. Mr. McDowell addresses himself to foundrymen who have trouble from dead, dirty and hard iron, large breakages and heavy losses in general. He discusses cupola melting, what is the cause of slow and hanging charges when the bottom is dropped, etc. The copies of the *Bulletin* containing these articles will be sent free to applicants who are interested in foundry practice.

GUSTAV WAGNER, Reutlingen, Würtemburg, Germany. Catalogue (in English) of Wagner cold sawing machines, automatic saw sharpening machines, rotary planing machines and vertical milling machines. The cold sawing machines are made in a great variety of styles and sizes adapted to a wide range of work. The saw is mounted on the end of a horizontal member and is adjustable around its support so that the saw can be presented against the work at any angle in the vertical plane. The saw thus can be used either vertically, horizontally or at any intermediate angle. One style is made with a circular table which enables a number of cuts to be taken on the same plate without resetting. This style is adapted for making cuts in locomotive drivers and similar work.

ADAMS CO., 360 White St., Dubuque, Iowa. Catalogue of the Adams-Farwell aeronautic motor, which was described in the July, 1908, number of MACHINERY. The motor is of the revolving cylinder type, having five cylinders mounted radially and revolving around a stationary crank-shaft. This arrangement of the cylinders makes unnecessary a cooling fan, radiator, fly-wheel, muffler, and other parts necessary on the ordinary stationary cylinder type. The five-cylinder motor with cylinders 4 3/16 inches bore and 3½ inches stroke, weighs 97 pounds, and is rated at 35 horse-power by the A. L. A. M. formula $\frac{D^2 \times N}{2.5}$. The engine "spins like a top" having a diameter of 27 inches and a height of 16 inches. The normal speed is 1,000 R.P.M., and maximum, 1,500 R.P.M. Price, $1,200.

COATES CLIPPER MFG. CO., Worcester, Mass. Catalogue No. 22 of the Coates flexible transmission apparatus, comprising flexible shafts, breast drills, drilling heads with radial arms, drilling heads with chain supports, magnetic holders for drills, portable buffing apparatus, etc. The catalogue also lists electric motor-driven drills and grinders having flexible shaft transmission. This apparatus is used for drilling, grinding, buffing, polishing, etc. The catalogue illustrates auxiliary apparatus used with the equipment, including radial arms, mongrel gear drive, speed multiplier attachment, grinding heads, silversmiths' outfits, mounted carborundum points, special carborundum wheels, lathe grinders, plain surface grinders, sander cones, screw polishing outfits, window washers, horse clippers, motor-driven erasers for the drawing room (see MACHINERY, January, 1909), electric hammers, electric massage machines, etc.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Handsome illustrated hanger having for a centerpiece a realistic foundry scene. Brawny bare-armed men are shown in the red glow of the molding room pouring molten metal from a Dixon crucible into the mold. The illustration is made from a photograph and is true to life. At the top of the hanger is an illustration in black and white of the Joseph Dixon Crucible Co.'s plant in Jersey City. This great factory and offices cover nearly eighty city plots. Other illustrations on the hanger show Dixon products made especially for foundry and metallurgical purposes, consisting of crucibles, stirrers, boxes and covers used in burning electric wire filaments and for casehardening purposes, mufflers, brazing crucibles, dipping cups, skimmers, etc. Some valuable hints are also given on the care and use of graphite crucibles. The hanger is sent free to anyone interested.

THE UNITED STATES ELECTRICAL TOOL CO., Cincinnati, Ohio. Catalogue F-1909 of the United States portable electrical tools, comprising hand and breast drills for drilling from 0 to ½ inch diameter; portable electrically driven drills for use with an "old man" or radial arm, having capacity up to 1¼ inch diameter; tool-post grinders made in a variety of sizes for use in engine lathes, boring mills, planers, etc., for producing ground circular and flat work. The company also makes a specialty of an attachment for grinding milling cutters which can be applied to the table of any milling machine, for sharpening cutters in position. This practice is desirable where very smooth work is required, as it is generally found impossible to remove the cutter from the arbor, grind and replace it so that all the teeth will cut exactly alike. When ground in position, a perfect division of work among all the cutter teeth is insured. The catalogue is sent on request to all interested.

BILLINGS & SPENCER CO., Hartford, Conn. Catalogue with discount sheet of machine tools and drop forgings of every description in steel, iron, copper, bronze, etc. The tools listed comprise Billings & Spencer wrench, adjustable automobile wrench, adjustable S-nut wrench, adjustable S-pipe wrench, adjustable spanner wrench, bicycle wrench, tap and reamer wrench, improved combination pliers, combined wire cutters and pliers, improved wire cutter, all-steel screw driver, magazine screw driver, gun- and machine-makers' screw drivers, belt awl, drop-forged plain riveting hammer, drop-forged machine hammer, ratchet drills, taper drill sockets, flat drills and counter-sinks, drop-forged lathe dogs, machine clamps, drop-forged steel C-clamps, planer tool-holders, lathe tool-holders, cutting-off tools, knurling tools, hand vises, drop-forged wrenches in a great variety of forms, socket wrenches, drop-forged steel snap gages, thumb screws, weldless eye bolts, automobile steering connections, drop-forged rod and yoke ends, automobile forgings, drop hammers, etc.

MANUFACTURERS' NOTES.

SIMONDS MFG. CO., Fitchburg, Mass., was awarded the grand prize at the Alaska-Yukon-Pacific Exposition, Seattle, Wash., for its exhibit of Simonds saws.

HILL-CLARKE & CO., Chicago, Ill., announces that on account of renumbering of the business places in the city its address will be changed from 14 South Canal St. to 125 North Canal St.

WESTERN ELECTRIC CO., 463 West St., New York, announces that it is now in a position to furnish "Sunbeam" tungsten lamps between 200 and 250 volts, and in four sizes: 45, 70, 112 and 180 watts.

CLEVELAND STEEL TOOL CO., Cleveland, Ohio, has instituted a suit for infringement of patent on its rolled head punches and split sleeves against the Cleveland Punch & Shear Works, and W. D. Sayle of Cleveland, Ohio.

WARNER & SWASEY CO., Cleveland, Ohio, builder of machine tools and manufacturer of optical instruments, will establish a Chicago branch, and has bought a three-story manufacturing block at 97-99 West Washington St., for that purpose.

COLBURN MACHINE TOOL CO., Franklin, Pa., announces that its former superintendent and boring mill expert, Mr. C. M. Robertson, is associated with the E. L. Essley Machinery Co., Chicago and Milwaukee, acting as salesman of the Colburn boring mills.

REMINGTON TYPEWRITER CO., 325 Broadway, New York, has found it necessary to enlarge the capacity of its Ilion, N. Y., factory to take care of increased business. Orders have been placed for an additional power unit and for machine tool equipment amounting to about $50,000.

S. OBERMAYER CO. reports that the fire in its Cincinnati plant, Saturday night, September 11, merely damaged its warehouse and did no damage to the manufacturing departments. There will be no interruption of its business, and orders will be filled with the same promptness as heretofore.

L. H. GILMER & CO., Philadelphia, Pa., have been compelled to move to larger quarters because of their rapidly growing business. The business has been removed from 504 Arch St. to 52 North Seventh St., where a large, commodious building with improved special machinery has been provided, for turning out the Gilmer endless belts.

CINCINNATI PULLEY MACHINERY CO., manufacturer of pulley lathes, riveting machines and ball-bearing drill presses, has removed from 218 Second St., Cincinnati, Ohio, to 16th St. and Licking River, Covington, Ky., where it has about four times its former floor space, and much better facilities for taking care of its rapidly increasing business.

WESTERN ELECTRIC CO., 463 West St., New York, is reported in the *Wall St. Journal* as doing a gross business of $47,000,000 per annum. The business for August showed a gain of 5 per cent over July and 60 per cent more than for August, 1908. Sales have been especially good during the past year in cables, electrical machinery and general electric light supplies.

WESTINGHOUSE MACHINE CO., Pittsburg, Pa., recently installed four Westinghouse vertical 13- by 12-inch gas engines in the Hoboken and Passaic plants of the Public Service Corporation of New Jersey for boosting the gas pressure in gas pipe lines. These engines operate direct connected to Root blowers, delivering gas at a pressure varying from ¾ pound to 4 pounds per square inch.

CURTIS & CURTIS CO., 8 Garden St., Bridgeport, Conn., maker of Forbes patent die stock, reports a decided improvement in business. It is running its plant at full capacity in all departments, and recently sold two of its largest machines having a range from 4- to 15-inch pipe to the Davis Coal & Coke Co., Thomas, West Va., and the Atlantic City Electric Light Co., Atlantic City, N. J.

FRANK B. GILBRETH, 60 Broad St., New York, has been awarded the contract for the construction of a brick and reinforced concrete publishing building at Plainfield, N. J., for the Engineering News Publishing Co., New York. The structure will be erected from plans by Mr. Frederick A. Waldron, 37 Wall St., New York, who has been retained as architect and industrial engineer in charge of the mechanical layout.

WARREN WEBSTER & CO., Trenton, N. J., was defeated in its suit against C. A. Dunham Co. for infringement of the Webster patents on vacuum heating apparatus. The suit was brought against C. A. Dunham Co., Marshalltown, Iowa, manufacturer of the Dunham radiator traps. The court held that there was no patentable novelty in the Webster apparatus, and it simply comprised an aggregation of old devices shown in prior patents.

GISHOLT MACHINE CO., Madison, Wis., manufacturer of drills, lathes, boring mills, tool grinders, etc., has opened a sales office in the Hudson Terminal Building, Room 1253, New York. The office is in charge of Mr. Ellis F. Muther, who is in charge of Gisholt interests in the East. The eastern agency arrangement formerly in effect has been discontinued. Under the new arrangement Gisholt business will be given the closest attention by Gisholt experts.

CLEVELAND AUTOMATIC MACHINE CO., Cleveland, Ohio, is from four to six months behind on deliveries of automatic screw machines, having so many orders on hand that February 1, 1910, is the best delivery date that can be offered now. At the present time from 225 to 265 machines are actually under construction and about 400 to 500 are ordered which will follow as fast as possible. The condition of business is as good as the company has ever experienced since it has been manufacturing automatic machines.

NATIONAL MACHINE & TOOL WORKS, Rockford, Ill., succeeds the firm of Dalin Bros., manufacturers of hand milling machines. Edwin Cedarleaf and O. J. Sundstrand have purchased the business and will continue to manufacture hand milling machines, and will do die and tool work and build special machinery. Messrs. Cedarleaf and Sundstrand are experienced machinists and machine designers and have improvements ready to incorporate in the hand milling machine. The new company desires to make connections for representation both at home and abroad.

ALFRED THOMPSON, 71 Broadway, New York, who has had much experience in South American trade, prophesies that the next ten years will be a Latin-American decade, and that the material economic, intellectual and political advancement to be witnessed in South America will rival that which has been accomplished in the United States. The country is gifted with a great variety of climates and resources, navigable rivers, long extent of coast line, and other natural advantages of incalculable value. American manufacturers should awaken to the potential possibilities for trade in this vast domain.

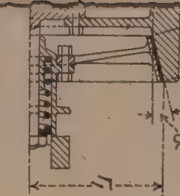
NIAGARA MACHINE TOOL WORKS, corner Jefferson, Superior and Randall Sts., Buffalo, New York (formerly the Niagara Stamping & Tool Co.), has purchased a seven-acre plot adjoining the N. Y. C. Belt Line in Buffalo, and on it will erect a group of modern buildings in which to carry on the manufacture of machinery for working sheet metals, including presses, squaring and rotary shears, tinsmiths' tools, etc. The new plant will provide the company with superior facilities for carrying on its business, which has been developed during the past thirty years, and which will soon exceed the limits of the present quarters. In the new plant ample facilities will be provided for taking care of domestic and foreign trade.

NATIONAL AIR FILTER CO., 100-201 E. Madison St., Chicago, Ill., manufacturer of electric air-purifying apparatus, has installed in the air ducts of the Chicago Public Library an ozone generator system for the purpose of purifying the air and deodorizing the thousands of volumes, books, papers and periodicals contained in that large building. The apparatus has a capacity sufficient for "ozonizing" 15,000 cubic feet of air per minute. The apparatus is operated from a feed wire of 110 volts which is connected to a step-up transformer discharging the current at a voltage of 7,000 into a series of electrodes through which the air passes. The current consumption for 10,000 cubic feet of air per minute is only 660 watts.

WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J., has improved the design of its surface condenser so that the coefficient of heat transferred has been increased from between 200 and 300 B.T.U. per square foot to between 800 and 900 B.T.U. per square foot per hour per degree F. average difference of temperature between the steam on one side of the surface and the water on the other. The importance of this increase is tremendous, especially to designing engineers of large power stations located on expensive land. It means that the condenser surfaces necessary are reduced from 2½ to 1 foot per rated horse-power, and removes one of the great obstacles to the steam turbine, *i. e.*, the excessive cost of condenser equipment required to give the high vacuum necessary for good economy.

5 3/8	137	11 9/16	23	46	69 1/10
5 1/2	140	12 1/10	24 1/5	48 2/5	72 3/5
5 5/8	143	12 5/8	25 5/16	50 5/8	75 15/16
5 3/4	146	13 1/4	26 1/2	53	79 1/2
5 7/8	149	13 13/16	27 5/8	55 1/4	82 9/10
6	152	14 2/5	28 4/5	57 3/5	86 2/5

Cone Clutch.



$$P = \frac{P_n f r N}{63025}$$

gement with some slip:

$$= \frac{P_s}{\sin \alpha}$$

$$= \frac{H.P. \times 63025 \sin \alpha}{f r N}$$

agement without slip:

$$= \frac{P_s}{\sin \alpha + f \cos \alpha}$$

$$\frac{H.P. \times 63025 (\sin \alpha + f \cos \alpha)}{f r N}$$

to RAILWAY MACHINERY, C

number entitled "Formulas for Cone Clutches" and "Standard Aut

A. L. A. M. STANDARD SPARK PLUG AND YOKE AND ROD ENDS

A. L. A. M. Standard Spark Plug

A. L. A

A. L. A. M. STANDARD YOKE AND ROD ENDS

A. L. A. M. Standard Solid Yoke and Eye Rod Ends

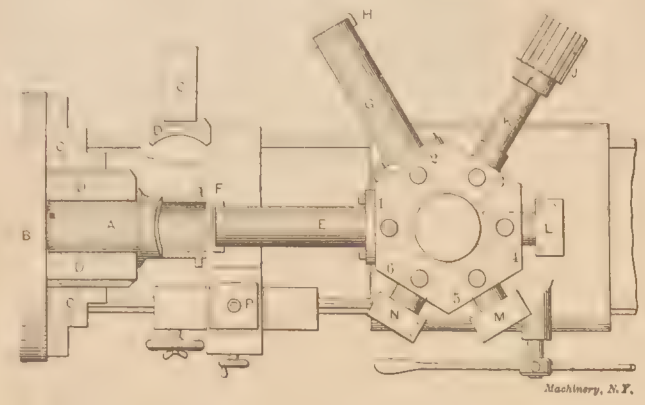
A. L.

Supplement to RAILWAY MACHINERY, October, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Boring Cylinders"

SHOP OPERATION SHEET NO. 112.

Oscar E. Perrigo. MACHINERY, October, 1909



Boring and Turning an Automobile Engine Cylinder Casting.

Note.—The turret lathe is supposed to be provided with a hexagonal turret, and a carriage supporting a rectangular revolving tool-post, with provision for four tools. The turret faces are also assumed to be bored for tool shanks, and drilled and tapped for bolting on large and heavy tools. The chuck *B* should be provided with strong and massive jaws for doing work of this kind.

1. To the soft chuck jaws *C* fit secondary jaws *D* having grooves formed in them for fitting the jaws *C*, as shown in the end view. Fasten these secondary jaws by small screws, and bore them out to fit the large diameter of the cylinder.

2. Provide the boring-bar *E*, with a shank fitting the hole in the turret, and a flange for bolting on to the turret face, and having its front end slotted and provided with the flat boring cutter *F* secured in place by a pin. The cutter should be of such length as to fully clean the rough bore of cylinder *A*, and should have its front corners somewhat rounded. Bolt this bar to turret face 1.

3. Provide for turret face 2 a boring-bar *G*, similar to that described in step 2, except that its cutter *H* is of proper length to bore 1/64 inch smaller than the finish diameter of the cylinder.

4. Provide for the turret face 3 a shell reamer *J*, of the exact diameter of the finished bore. The ends of the teeth should be somewhat rounded, and the reamer fitted loosely to the arbor *K*.

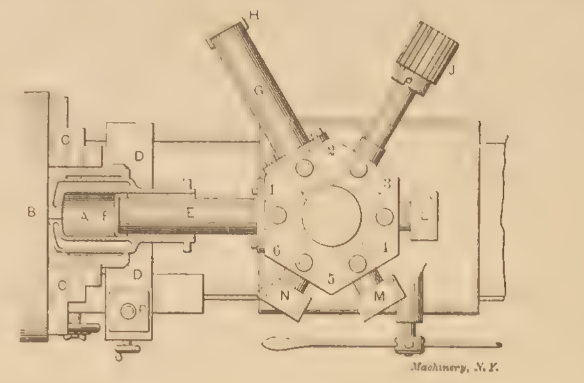
NOTE.—It is the practice in many shops, particularly where gasoline engines are manufactured, to finish the bore of the cylinders by grinding.

5. Provide and place in turret faces 4, 5 and 6, tool-holders *L*, *M* and *N*, suitable for holding square tools.

NOTE.—The tools for use in the holders *L*, *M*, *N*, and in the rectangular tool-post *P*, will be described in Operation Sheet No. 113, as they are necessarily brought into use in connection with the facing operations.

SHOP OPERATION SHEET NO. 113.

Oscar E. Perrigo. MACHINERY, October, 1909



Boring and Turning an Automobile Engine Cylinder Casting.

NOTE.—The cylinder *A* is shown in section, held in place by the secondary jaws *D*, which are attached to the regular jaws *C* of the chuck *B*, and with its large end resting against the face of the chuck. The turret is fitted with the tools necessary for the operations, which have been previously described.

1. Place the casting A within the jaws *D*, and screw up the chuck jaws lightly. Start the machine slowly, holding a piece of chalk against the outside of the rough casting at the outer end. If necessary, slightly change the position of the casting *A*, as indicated by the chalk marks, until the casting runs practically true. Screw up the jaws gradually and successively until the casting is fully secured; proper care should be taken to prevent crushing its thin walls. When the casting is clamped, it should be again tested and adjustment made if necessary.

2. Bring up the rough boring-bar *E*, and start the cut with its tool *F*, using a coarse feed. If the tool chatters, it will be necessary to reduce the feed. Stop the feed as soon as the rounded corners of the cutter have cleaned the bottom of the bore.

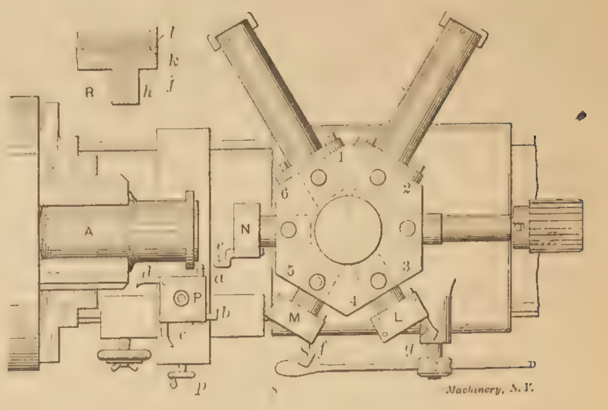
3. Withdraw the roughing tool-bar *E*, bring the sizing tool-bar *G* into operative position, and take a second cut, using the same care as to the feed, and stopping it when the bottom of the bore is reached.

4. Withdraw the sizing tool-bar *G*, turn the turret until the reamer *J* is in operative position, and proceed to ream the bore by forcing the reamer carefully, by hand, to the bottom of the bore.

NOTE.—While the roughing and sizing cutters are at work, chips may collect in the bore so as to make it necessary to withdraw the tool and clean them out. This will most likely occur if a small or distorted core was used in making the casting. If chips are allowed to clog the cutters, the surface of the bore may be "roughed up" by them.

SHOP OPERATION SHEET NO. 114.

Oscar E. Perrigo. MACHINERY, October, 1909



Boring and Turning an Automobile Engine Cylinder Casting.

NOTE.—The casting *A*, which has been bored and reamed, remains in the chuck at the conclusion of those operations. The form of the mouth of the cylinder bore and the flange surrounding it is shown on an enlarged scale at *R*. The cross slide carriage is clamped to the bed throughout these operations.

1. Place a bent rough facing tool *a* in the tool-post *P*. Set it to face the front *h* of the flange to 1/32 inch of finish dimension and take the cut.

2. Place a bent finish facing tool *b* in the tool-post *P*. Set it to face the front *h* of the flange to the finish dimension and take the finishing cut.

3. Place a bent rough facing tool *c* in the tool-post *P*. Set it to rough face the end *k* of the cylinder to 1/32 inch of the finish dimension and take the cut.

4. Place a bent finish facing tool *d* in the tool-post *P*. Set it to finish face the end *k* to finish dimension and take the cut.

5. Place the offset rough turning tool *e*, in turret tool-holder *N*, and set it 1/16 inch over finish diameter at *j*. Bring the tool up and rough turn this portion down to the face *h*.

6. Place the offset finish turning tool *f* in the turret tool-holder *M*, and set it to finish diameter *j*. Bring the tool up and finish this diameter down to the face *h*, making a sharp corner.

7. Place the straight chamfering tool *g* in the turret tool-holder *L*, and set it to cut the chamfer *l* to the angle required. Bring up the tool and cut the chamfer, using the hand feed.

NOTE.—It is understood that the regular adjustable stops of the machine are to be used in limiting the travel of the tools; that the hand wheel *p* is used for operating the tool-post *P*, and the pilot *s* for operating the turret tools on short cuts, etc.

Supplement to RAILWAY MACHINERY, October, 1909

Formulas and Tables for the Articles in this number entitled "Formulas for Cone Clutches" and "Standard Automobile Parts Adopted by the A. L. A. M."

FORMULAS FOR CONE CLUTCHES

H.P. - horse-power transmitted,

N - revolutions of crank-shaft per minute,

r = mean radius of friction cone, in inches,

r_1 = large radius of friction cone, in inches,

r_2 = small radius of friction cone, in inches,

R_1 = outside radius of leather band, in inches,

R_2 = inside radius of leather band, in inches,

v = velocity of a point at distance r from the center, in feet per minute,

F = tangential force acting at radius r, in pounds,

P_n = total normal pressure between cone surfaces, in pounds,

P_s = spring pressure, in pounds,

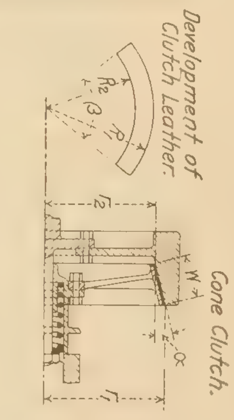
α = angle of clutch surface with axis of shaft = 7 to 13 degrees,

β - included angle of clutch leather, when developed, in degrees,

f - coefficient of friction = 0.20 to 0.25 for greasy leather on iron,

p = allowable pressure per square inch of leather band = 7 to 8 pounds,

W = width of clutch leather, in inches.



$$R_1 = \frac{r_1}{\sin\alpha} \qquad H.P. = \frac{P_n f r N}{63025}$$

$$R_2 = \frac{r_2}{\sin\alpha}$$

Engagement with some slip:

$$\beta = \sin\alpha \times 360 \qquad P_n = \frac{P_s}{\sin\alpha}$$

$$r = \frac{r_1 + r_2}{2} \qquad P_s = \frac{H.P. \times 63025 \sin\alpha}{f r N}$$

$$v = \frac{2\pi r N}{12}$$

Engagement without slip:

$$F = \frac{H.P. \times 33000}{v} \qquad P_n = \frac{P_s}{\sin\alpha + f\cos\alpha}$$

$$W = \frac{P_n}{2\pi r p} \qquad P_s = \frac{H.P. \times 63025(\sin\alpha + f\cos\alpha)}{f r N}$$

Contributed by C. A. Schaefer

HORSE-POWER OF AUTOMOBILE ENGINES

A. L. A. M. Standard

Horse Power of Automobile Engines.
Based on the A.L.A.M. Standard Horse Power Formula, assuming a piston speed of 1000 feet per minute.

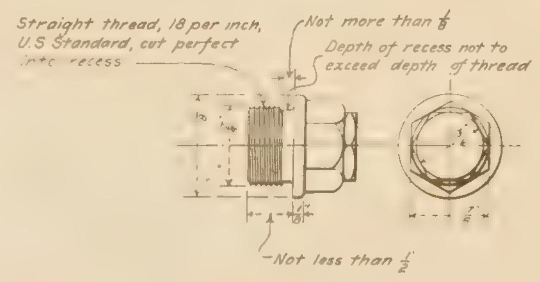
$$H.P. = \frac{(\text{Diam. of cyl.})^2 \times \text{No. of Cylinders}}{2.5}$$

Diameter of Cylinder		Horse Power			
Inches	Millimeters	1 Cylinder	2 Cylinders	4 Cylinders	6 Cylinders
2 1/2	64	2 1/2	5	10	15
2 5/8	68	2 3/4	5 1/2	11	16 1/2
2 3/4	70	3	6	12 1/10	18 1/5
2 7/8	73	3 5/16	6 5/8	13 1/4	19 7/8
3	76	3 3/5	7 1/5	14 2/5	21 3/5
3 1/8	79	3 15/16	7 13/16	15 5/8	23 7/16
3 1/4	83	4 1/4	8 1/2	16 9/10	25 2/5
3 3/8	85	4 9/16	9 1/8	18 1/4	27 2/5
3 1/2	89	4 9/10	9 4/5	19 3/5	29 2/5
3 5/8	92	5 1/4	10 1/2	20 1/4	31 3/5
3 3/4	95	5 5/8	11 1/4	22 1/2	33 3/4
3 7/8	99	6	12	24	36 1/16
4	102	6 2/5	12 4/5	25 3/5	38 2/5
4 1/8	105	6 13/16	13 5/8	27 1/4	40 9/10
4 1/4	108	7 1/4	14 1/2	28 9/10	43 4/5
4 3/8	111	7 5/8	15 5/16	30 5/8	45 15/16
4 1/2	114	8 1/10	16 1/5	32 2/5	48 3/5
4 5/8	118	8 9/16	17 1/8	34 1/4	51 3/5
4 3/4	121	9	18	36 1/10	54 1/10
4 7/8	124	9 1/2	19	38	57
5	127	10	20	40	60
5 1/8	130	10 1/2	21	42	63
5 1/4	133	11	22	44 1/10	66 1/5
5 3/8	[illegible]	[illegible]	23	46	69 1/10
5 1/2	140	[illegible]	24 1/5	48 2/5	72 3/5
5 5/8	143	[illegible]	25 5/16	50 5/8	75 15/16
5 3/4	146	[illegible]	26 1/2	53	79 1/2
5 7/8	149	[illegible]	27 5/8	55 1/4	82 9/10
6	152	14 2/5	28 4/5	57 3/5	86 2/5

A. L. A. M. STANDARD SPARK PLUG AND YOKE AND ROD ENDS

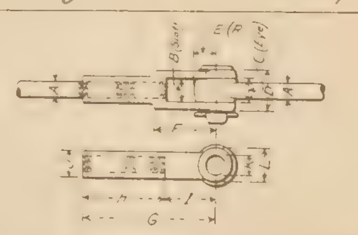
A. L. A. M. Standard

A. L. A. M. Standard Spark Plug



Association of Licensed Automobile Manufacturers Standard Threads, Screws, Castle and Plain Nuts:—See MACHINERY'S Data Sheet No. 63, November 1906.

A.L.A.M. Standard Adjustable Yoke and Eye Rod Ends



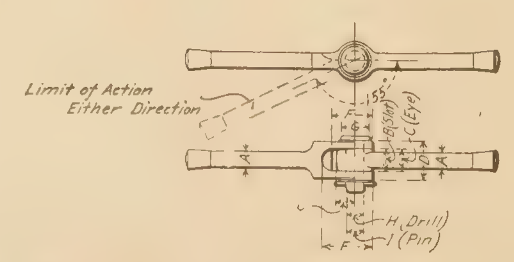
Rod A	Thread	Slot B	Eye C	D	E	F	G	H	I	J	K	L
1/4	1/4 x 28	7/16	0.432	3/4	3/8	1 1/4	2 3/8	1 3/8	1	1/2	5/16	11/16
5/16	5/16 x 24	[illegible]	0.495	7/8	7/16	1 3/8	2 3/4	1 5/8	1 1/8	9/16	13/32	3/4
3/8	3/8 x 24	19/32	0.588	1	1/2	1 1/2	3 1/8	1 7/8	1 1/4	21/32	5/32	7/8
7/16	7/16 x 20	21/32	0.651	1 1/8	17/32	1 11/16	3 5/8	2 1/4	1 3/8	3/4	9/16	15/16
1/2	1/2 x 20	3/4	0.770	1 1/4	5/8	1 7/8	4	2 1/2	1 1/2	13/16	5/8	1 1/16

A. L. A. M. Standard

A. L. A. M. STANDARD YOKE AND ROD ENDS

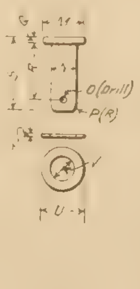
A. L. A. M. Standard

A.L.A.M. Standard Solid Yoke and Eye Rod Ends



Rod A	Slot B	Eye C	D	E	F	G	Drill H	Pin I	J
1/4	7/16	0.432	3/4	1 1/32	25/32	1/2	5/16	0.310	3/8
5/16	1/2	0.495	7/8	1 7/32	15/16	5/8	13/32	0.403	7/16
3/8	19/32	0.588	1	1 3/8	1 1/16	3/4	15/32	0.465	1/2
7/16	21/32	0.651	1 1/8	1 9/16	1 3/32	7/8	9/16	0.559	17/32
1/2	3/4	0.745	1 1/4	1 11/16	1 5/16	15/16	5/8	0.621	5/8

A.L.A.M. Standard Pin and Washer Dimensions



Size Rod	1/4	5/16	3/8	7/16	1/2
M	1/2	5/8	3/4	7/8	15/16
N	0.310	0.403	0.465	0.559	0.621
O	5/64	5/64	7/64	9/64	11/64
P	5/16	13/32	15/32	9/16	5/8
Q	3/32	3/32	1/8	1/8	1/8
R	53/64	61/64	1 3/32	1 17/64	1 3/8
S	1 3/32	1 1/4	1 7/16	1 5/8	1 3/4
T	1/32	1/32	1/32	1/16	1/16
U	1/2	5/8	3/4	7/8	1
V	5/16	13/32	15/32	9/16	5/8

// RAILWAY MACHINERY

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics

November, 1909

A NEW ENGINE PILOT TRUCK

CHARLES R. KING*

ECONOMY of weight and space has been the purpose in the introduction on several European railway systems of a new form of pivoting pilot truck for locomotives, in which a sort of Bissel two-wheeled truck is combined with one of the pairs of driving wheels, thus constituting a four-wheeled truck with all its advantages.

Trucks built on this principle have been used for many years on south German railways where they were first introduced by Herr Von Helmnholtz of the firm of Krauss of Muenchen in Bavaria. Recently this type of truck has been much improved by Cavalier Giuseppe Zara of the State Railways of Italy, and it has proved to be very satisfactory in other countries besides.

The accompanying engraving shows the details of the construction of a Zara type truck as adopted by the Federal Railways of Switzerland. This truck has been applied to thirty locomotives of the 2—6—0 type by the Locomotiv-u. Maschinenfabrik of Winterthur. The improvement consists in the provision of springs by means of which the pivoting center of the truck is forced back into its central position whenever the locomotive emerges from a curve onto a straight line.

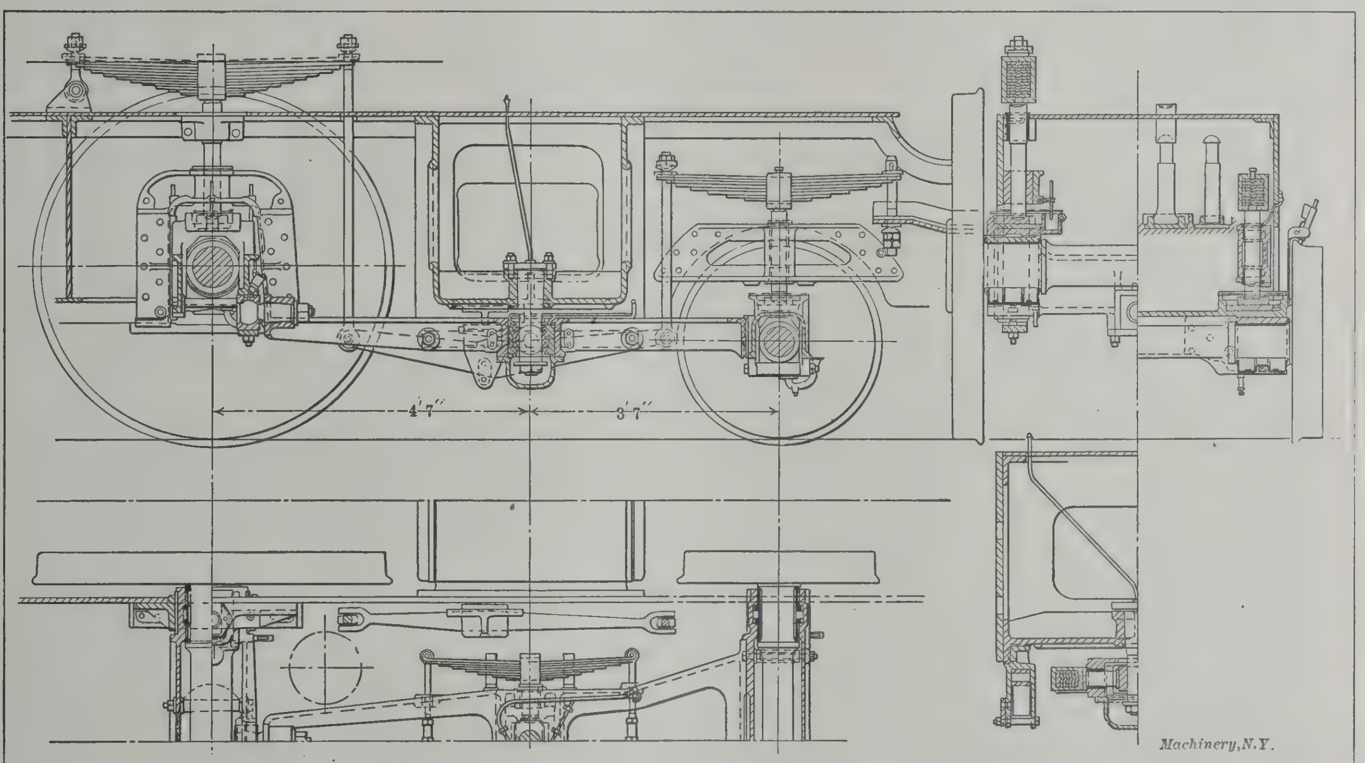
Briefly, it may be explained that the Helmnholtz conjugated truck has a rigid center, and when the locomotive enters a curve the small front wheels turn about this center, while the rear end of the truck, attached to a box casing on the driving axle close up to each driving box, moves the driving axle laterally in correspondence with the radial movement of the front pair of wheels and always in an opposite direction to each other.

The Italian type adopted in Italy differs, in that the center of the truck is not fixed, but swings laterally upon the links by which the main frames are suspended from it, consequently the return-action of the two frames, in due alignment with the rails, is due to the action of gravity.

The latest type, herewith illustrated, differs from the Italian in having springs acting against the sides of the pilot truck frame, in place of swing links, these springs each having an initial tension of from 2,200 to 3,300 pounds. The truck frame is now made much more flexible by attaching it to only one point on the box-casing of the front driving axle, and the attachments are always spherical to prevent strain. The pivot center, the side-rod pins, and the axle boxes themselves, all have spherical surfaces as designed by Signor Zara of the Italian State Railways.

In actual service, these elastic arrangements of the rolling gear are found to be particularly suited to the very crooked lines of railway quite common in Italy and Switzerland, where trains are daily run at 55 miles per hour through series of snake-like loops, buckles and turns having only 1,000 feet radius, and with perfect ease. The question of dead weight is also of very great importance owing to the restricted axle load of under 15 tons. The saving of weight by the use of the conjugated four-wheeled truck is two tons, and those two tons saved enable the use of larger boilers without increasing the total weight of the locomotive.

Such has been the success of the conjugated pilot truck in Italy, that the ordinary four-wheeled truck has been totally abandoned in current practice. For exceptionally heavy locomotives, in proportion to the power available (as for instance single-expansion engines using superheated steam), it appears most probable that the four-wheeled truck will have to be reintroduced in the course of a year or two, but in awaiting these experiments with single-expansion locomotives, and for which the trunk lines will have to be strengthened in order to carry loads of two tons extra per axle, the two-wheeled truck, in combination with the compound system, enables engines to be designed with the minimum wheel-base and the minimum weight per horse-power that it is possible to obtain in a railway locomotive.



Zara Type of Pilot Truck adopted by the Federal Railways of Switzerland

* Address: Staple Hill Park, Staple Hill, near Bristol, England.

CHAIN-MAKING EXTRAORDINARY IN A SCRAPLESS PRESS-ROOM

CHESTER L. LUCAS*

TWENTY-FIVE thousand links of steel sprocket chain, automatically punched, formed and assembled complete in one day of 10 hours! This is the remarkable, though everyday performance of each of the many automatic chain presses in the factory of the Locke Steel Belt Co., of Bridgeport, Conn., manufacturers of steel belt or sprocket chain.

This chain is made primarily for two classes of work: agricultural machinery, such as planters, mowing machines, harvesters, etc., and for conveying and elevating machinery in the mining, grain and other similar industries. The chain is made to meet all requirements, being made in varying sizes from ½ to 3 inches in width, and in thicknesses from 0.045 to 0.250 inch. During the making of this chain not an ounce of the stock is wasted in scrap, excepting a small "scallop" at the beginning and another at the end of each coil of steel. The part of the link which is punched to form the opening in the center is curled around and serves to connect the link with the one following. Thus, 100 feet of steel ribbon enters the press from one side and emerges on the other side as 95 feet of completed chain—the slight shrinkage being due to the bending of the steel in forming the link. The steel used is of low carbon, and comes in large coils ready for the press, having been rolled to the right width for the size chain into which it is to be made; therefore all sharp edges that would result from sheared stock are eliminated. The chain is easily parted at any desired point by simply bending a link backwards as far as possible and slipping it out edgewise.

The Automatic Chain Press

The principal feature of the making of this chain is the automatic chain press shown in Fig. 1. This type of machine was specially designed and built for the work, and as the results will testify, it has been highly satisfactory. In general, it resembles and in fact is, a heavy, powerfully-geared, triple-action press. At the right of the illustration may be seen a roll of stock being fed to the press, and just outside of the housings of the press is located the feeding device which is patterned after the familiar grip feed. The main point of this feed is its positive action, which is absolutely necessary on account of the construction of the dies themselves. If, for example, the stock and partly completed links should, through failure of the feed, be advanced but half the required distance, the dies would be badly damaged at the next stroke of the press. Fig. 2 shows the feed in cross section, and its operation is as follows: As the connecting-rod *A* descends (actuated by a crank on the driving wheel) it causes link *B* to recede, carrying with it part *C*, which upon reaching lug *D*, pulls back the feed finger *E* in conjunction with slide *F*, of which it is a part. When the end of the stroke is reached, the forward motion throws the feed finger *E* with its jaw, into the stock, forcing it hard against the corresponding jaw in the slide beneath the stock. Between these two jaws the stock, with the whole slide, is carried forward the distance required to form one link. To prevent the slide *F* from moving forward before finger *E* has gripped the stock, a spring pressure plate *G* is provided which bears against the slide. Before the steel ribbon enters the feed, it passes between a set of straightening rolls that effectively removes any kinks or dents that would interfere with the action of feed or dies.

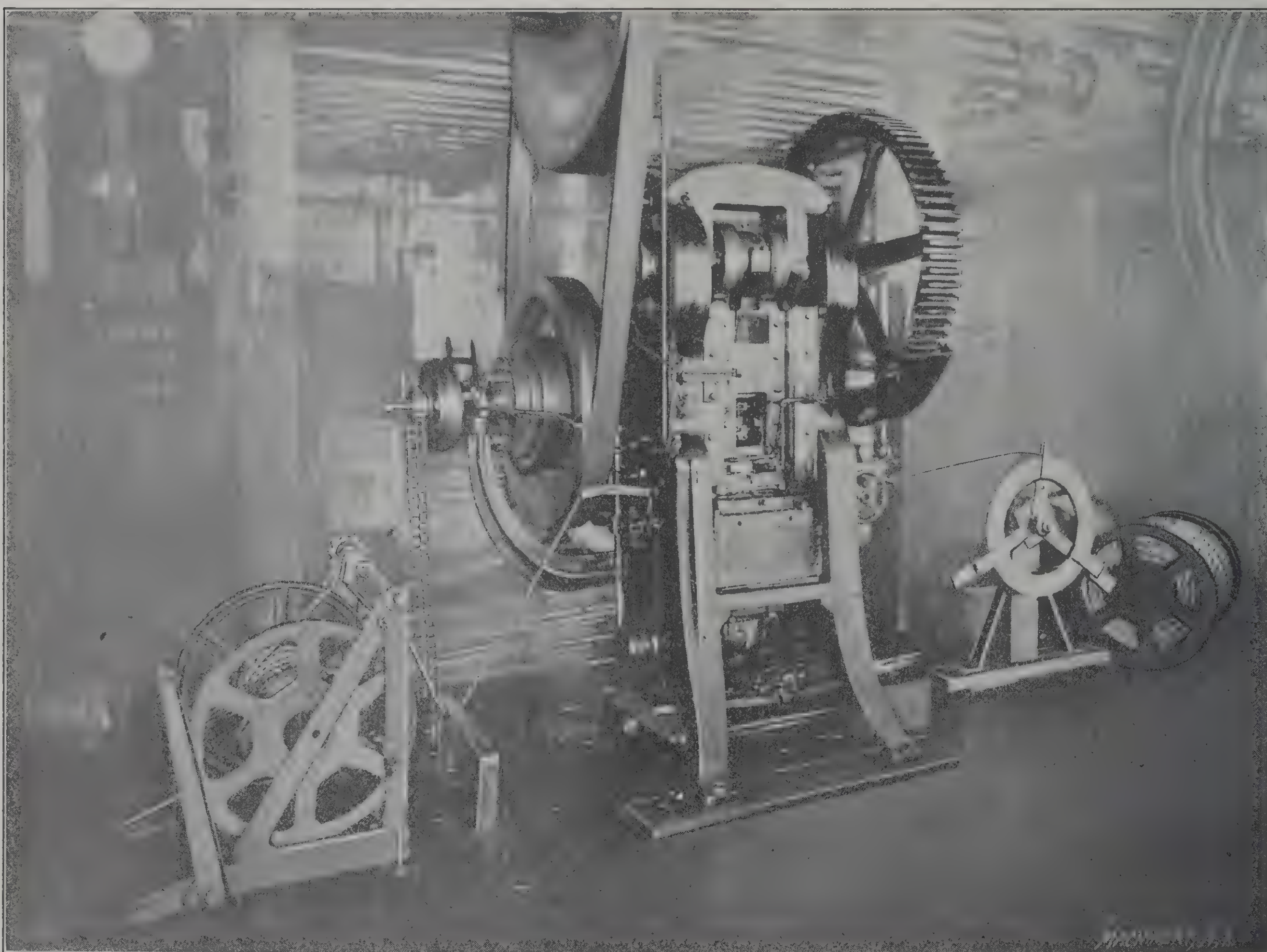


Fig. 1. Automatic Chain Press and Reel upon which Finished Chain is wound

The Dies

The dies used in this chain press are very interesting. Although of a modified design, they are after the style of the ordinary follower die; several operations of the chain making being performed upon as many different sections of the stock at each stroke of the press. Another noticeable feature is that all wearing parts, such as punches, scoring chisels, etc., are so arranged in the dies that they may be easily removed without interfering with the rest of the dies, thus facilitating adjustment and renewal. The bodies of the first chain dies were made of tool steel; later machine steel was used, and at the present time machine steel case-hardened to a

* Address: Saugus Station, Lynn, Mass.

depth of 1/16 of an inch, is giving better satisfaction than either the unhardened machine steel or the tool steel.

The press tools for the making of the chain are shown in Figs. 3 and 4; these may properly be divided into four parts: the punch *A*, which is held and operated by the main ram of the press; the plate (or stripper) *B*, which is held and operated by the cam-slide; the principal die *C* (also shown in plan view in Fig. 4) fastened to the bed of the press; and the finishing die *D* held and operated by the triple-action mechanism beneath the bed of the press. The function of plate *B* is to hold the body of the chain while punch *A* with its sections *b*, *c*, *e*, *h* and *j* are performing their work on the links and also while finishing die *D* is at work on the under side of the stock, connecting the links. Just before punch *A* does its work, plate *B* is clamped upon the stock by means of a cam-slide, and held there until the upward stroke releases it.

After leaving the straightening rolls, the stock enters the feeding mechanism already described, and by it is advanced the length of one link under the dies. The first stroke of the press forms the stock over the rounding projection *a* in the die; at the same time, on the under side of the stock, scoring chisels b_1 in the die meet scoring chisels *b* in the punch, on the top side of the stock. While the hump is being formed over *a*, the scoring chisel *c*, located at the top of the hump in the punch, does its work, making a cut clear across and half way through the stock, to facilitate the separation of the links in a succeeding operation. The result of this stroke of the press is indicated by the letters *A* in the illustration, Fig.

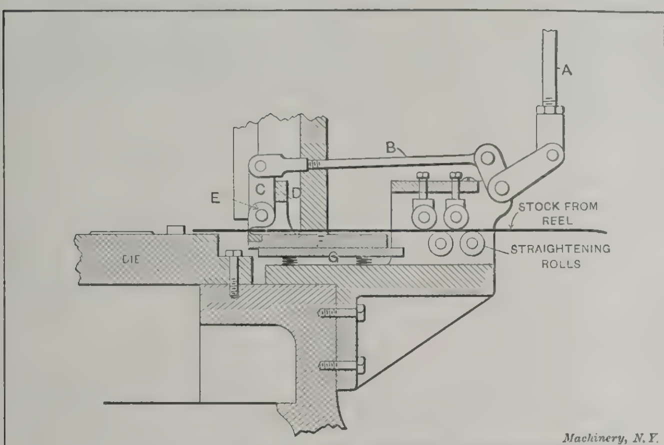


Fig. 2. Positive Feeding Mechanism which advances the Stock the Length of a Link at each Stroke

5, which shows the appearance of the top and bottom of the stock. While the upward return of the press is under way, the feed is advancing the stock another link's length forward, bringing the hump just formed into position over projection *d* in the die. When the press comes down on the second stroke, scoring chisel e_1 in the die and *e* in the punch make opposite cuts that connect the first two cuts made, near their rear ends, thus outlining three sides of what is to be the open space at the center of the link. Wfth this stroke, figure punch *f*, located in plate *B*, stamps the size of chain into each side of the face of the link. This stroke leaves the stock in the condition shown at *B*, Fig. 5.

The semi-completed links are again forwarded one length, bringing the first hump over shearing knife *g* in the die. On the third down-stroke section *h* in the punch separates the stock on the short scored cross line and pushes it in either direction into the die cavity *i*. This step is plainly shown at *C*. The stock is advanced again for the final operation of completing and connecting the links. As the punch descends, section *j* separates and pushes well down into the die, the center of the link, which operation takes but little pressure, as it has already been deeply scored on both sides. Simultaneously, section *k* of plate *B* severs the link where it has been previously scored. At this point, inverted punch *D*, operated by the triple-action mechanism beneath the press bed, receives the link tongue in the section *n* and then rises, pushing the link tongue upward and through the center of the link ahead. At the end of its upward journey the tongue strikes the depression in plate *B*, which rounds it nicely into shape, thus connecting it with the forward link and completing the operation of making the chain. A projection *l* is placed in this recess to prevent the link from entirely closing, which would make separation of the completed links impossible. During the linking operation, the balance of the stock, outside of the opening, is held by plate *B* against pro-

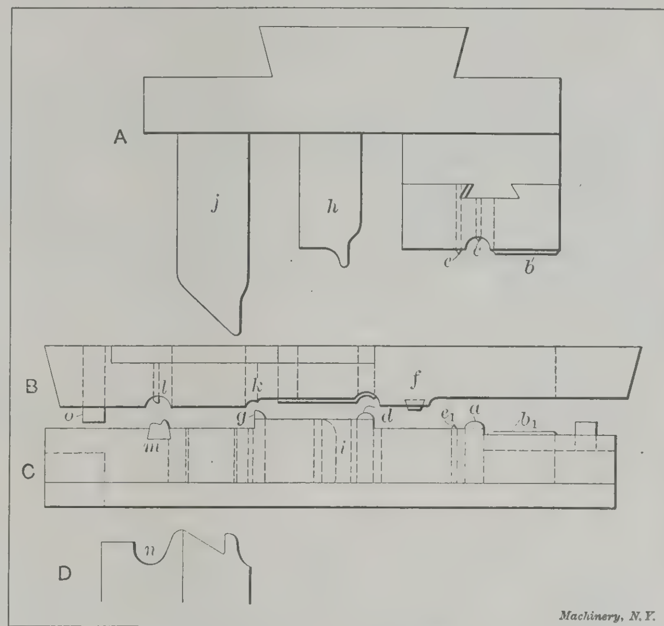


Fig. 3. The Dies used in the Chain Press

jection *m* and the rest of the die. Stop *o* is added to the dies to insure that the finished chain is pulled from the dies but one link at each stroke of the press. As the link nearest completion is severed from the balance of the stock, it is plain that it would be pulled too far by the winding mechanism if stop *o* did not drop into the opening of the preceding link and hold the link following in position for the linking operation.

While the operations just described have been taking place on the first link other links have of course been started, so that at each stroke of the press four different links are undergoing the various operations and one link is completed and connected with the finished chain that is being wound on the reel at the left of the press.

The Reel

As the completed chain leaves the press it passes under a cam-lever and thence to the reel at the left of the press, as

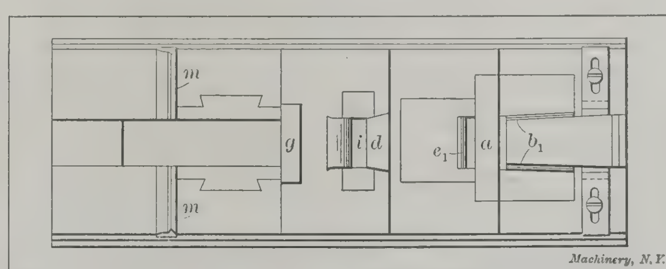


Fig. 4. Plan View of the Die shown in Fig. 3

shown in Fig. 1. The solving of the winding problem was not as simple a matter as it would at first appear. To begin with, the reel weighs over 100 pounds empty and wound with chain, over 500 pounds; therefore the mechanism must be strong and simple, especially as the weight is constantly changing. Secondly, at the starting of the empty reel only about two feet of the chain is wound in one revolution, but when the reel is nearly filled, from eight to ten feet are wound in one revolution, consequently the reel winding must be intermittent. Thirdly, adequate means had to be provided for winding the chain in even layers in order that it might be easily unreeled in subsequent handling.

The reel is about three feet in diameter and made of heavy iron with the sides perforated to reduce the weight as well as to allow the oil better circulation in the tempering bath, which will be described later on. In use, the reel is sup-

ported on four small rollers at the base of its support; the rear set acts as driver and transmits the power for turning the reel. When the lever at the side of the reel is thrown down, the rear set of rollers drops back and allows the reel to roll out of the frame. The scheme for obtaining the intermittent motion to the reel-winding is simple. To the driving mechanism (which by the way is operated by power conveyed from the press by a Locke steel chain) is added a friction clutch, controlled by the cam-lever under which the chain passes on its way to the reel. When the chain is being wound too fast, it pulls up against the cam-lever, which by this upward motion disengages the friction clutch and stops the reel. After enough chain accumulates to allow the lever to drop and thus engage the clutch, the reel starts again. The chain is wound in even layers by the screw at the top of the reel which is made with a double (forward and reverse) thread. The carriage over which the chain passes is thus guided slowly backward and forward as the reel is wound, thereby producing a regular and evenly wound reel.

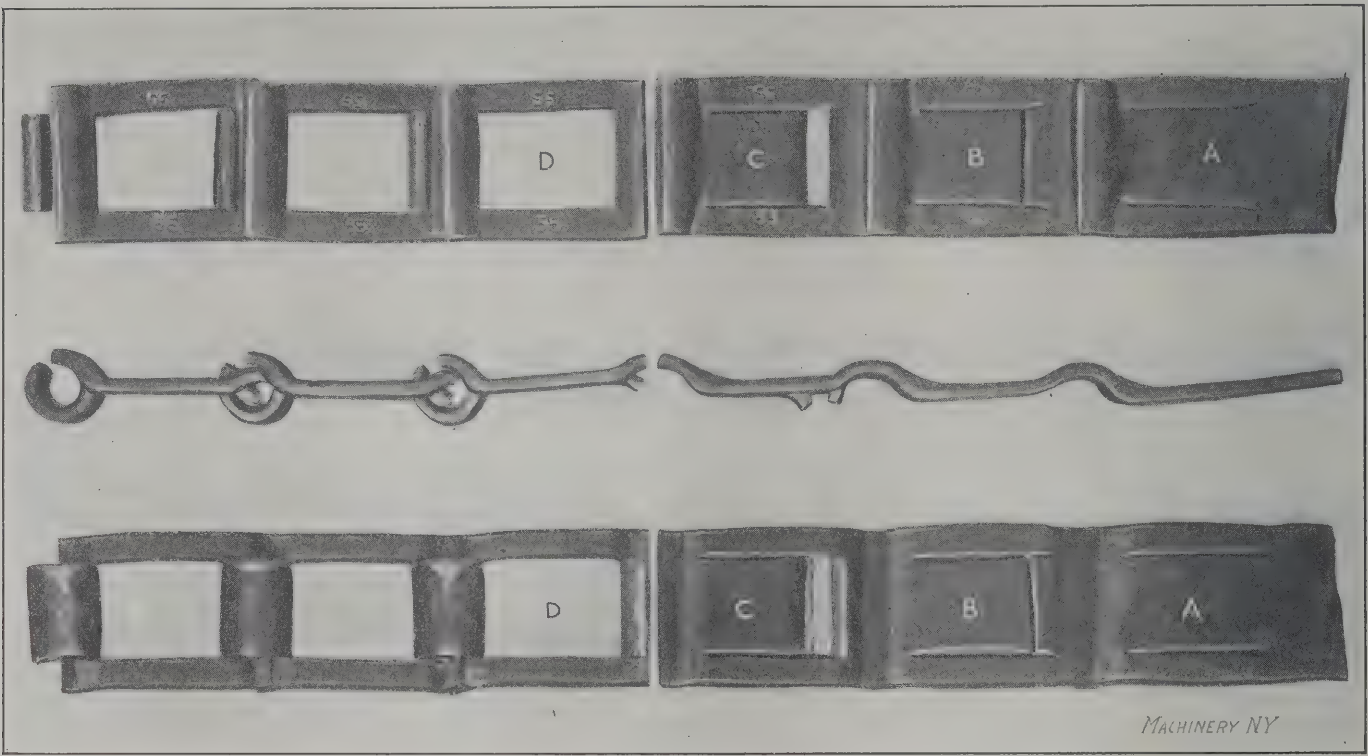


Fig. 5. The Four Successive Steps in making the Chain, and the Completed Links

The Hardening Furnace

In many respects the most interesting part of this chain-making plant is the hardening room. To this department the reels of completed chain are brought, and by means of hardening furnaces like those shown in Fig. 6, the soft steel links are automatically hardened. As each link receives the same heat for the same length of time and is quenched in a bath of never-varying temperature, it is obvious that each link of the chain must be thoroughly and evenly hardened.

The illustration Fig. 7 shows a sectional view of the furnace and tank. The incline is lined with firebrick and the heat is supplied through four burners *B* which burn crude petroleum. The chain leaves the reel at the base of the furnace and passing over the sprocket wheel *A* enters the incline, through which it passes at the rate of from 6 to 10 feet a minute, entering the hardening tank shown at the foot of the incline in a bright cherry red heat. After dropping deep into the tank the chain is brought up and over sprocket wheel *C* and thence to the reel where it is wound in the manner already described. By referring to the illustration, it will be noticed that from the time the chain leaves the sprocket wheel *A* at the top of the furnace, until it reaches the sprocket wheel *C* at the end of the hardening tank, it comes in contact with nothing except the red-hot firebrick and water. In this way it is plain that there can be no danger of the hot links being stretched and thereby affecting the pitch of the chain. Provision is made for adjusting the heat in the furnace to suit large or small chain, and the machine is fitted with cone pulleys to regulate the speed at which the chain passes through.

With a line of red hot chain constantly entering the hardening tank, it does not take long to heat the water. To keep the water cool, a large supply pipe is steadily emptying cold water into the tank and at the side is an overflow pipe to carry away the warm water. One little kink on this machine deserves mention, and that is the utilizing of the exhaust heat to dry the chain as it comes out of the tank, dripping wet. As in the other reel drives, the power for this machine and its reel is transmitted by chain similar to that under process of making.

Tempering

The hardened chain which is of course very brittle in its extreme hardness, now undergoes the tempering process.

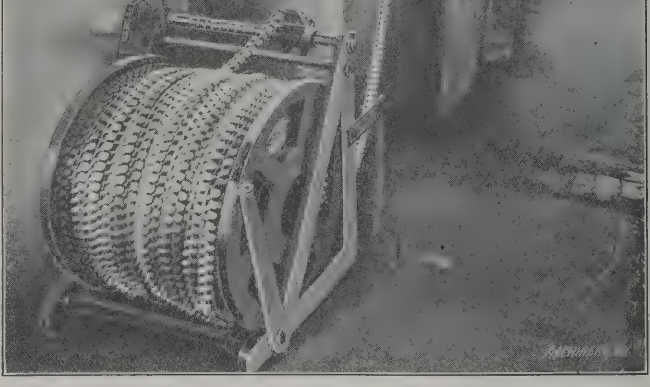


Fig. 6. Chain passing from the Reel into the Hardening Furnace

Great vats of neatsfoot oil are heated to a temperature of 620 degrees F. and into these the full reels of chain are lowered by means of cranes. In this hot oil the reels are left for half an hour, which reduces the temper to a point where the steel has its maximum toughness. Next, the reels of

chain are placed on an iron plate which is kept continuously hot, and upon this plate they are left until the adhering oil is baked hard upon the surface of the chain.

Inspection

The tempering operation really completes the chain, yet it is put through a very rigid test which precludes the chance of a single defective link escaping. Fig. 8 shows a view of the testing department and testing apparatus. Here the chain

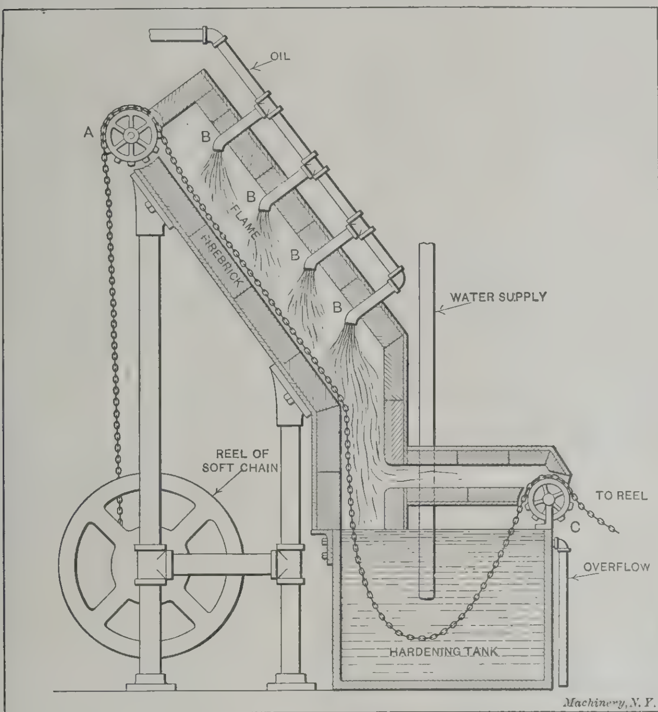


Fig. 7. Sectional View of the Automatic Hardening Furnace

is separated into 10-foot lengths or, if required, into special lengths, as may be seen in the background. Each of these lengths is stretched out upon the testing bench and compared with a standard 10-foot length of the same pitch. If it agrees within the required limits, one end is held by a hook at the end of the bench and the other end attached to the testing apparatus shown. The main lever of this device is studded with pin holes, and by means of a pin and different weights the required testing pressures can be applied to the

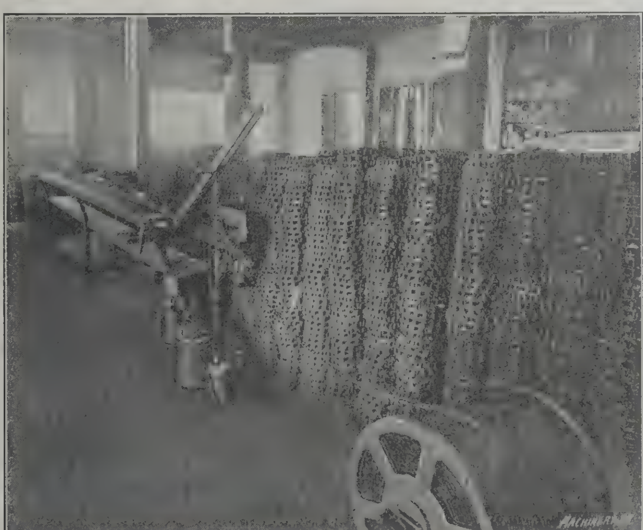


Fig. 8. Department where the Chain is tested

various sizes of chain. It is then again compared with the standard to detect stretching. As the chain is drawn from the reels, it is pulled through a series of sprockets to discover any stiff or otherwise faulty links that may be in it. Each and every link undergoes this exacting examination, and, as two men will put 20,000 feet of the chain through the various tests in one day, the process is not as slow as it would at first seem.

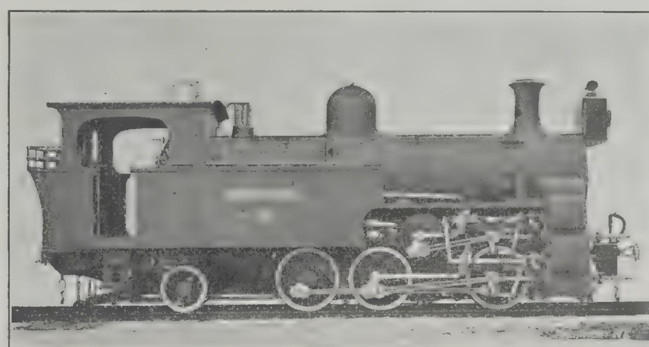
It is not necessary to apply oil to the chain prior to shipment, as the oil tempering operation leaves the chain with a film of oil, baked on, which not only protects the steel from the action of air and water, but gives the chain a durable glossy black finish that satisfactorily completes the manufacture of a superior sprocket chain.

* * *

GERMAN FOUR-CYLINDER COMPOUND ADHESION AND RACK LOCOMOTIVE

FRANK C. PERKINS*

The accompanying illustration shows the construction of the Benguella rack locomotive *Marquis De Soveral* as constructed on the Riggenbach system in Germany by the Maschinenfabrik Esslingen. This rack locomotive was constructed for a gage of 3 feet 6 inches (1,067 millimeters). It is provided with a tender when in service, having a tank capacity of 3 tons of water and a coal bunker capable of holding one ton of fuel. This engine was designed for rack and adhesion service and weighs, empty, 37.35 tons, and in working order 45.34 tons. The boiler was designed for operating at a pressure of 200 pounds per square inch, and it has a grate area of 1.864 square meters while the fire-box heating surface is 9.25 square meters. The total heating surface outside is 105.228 square meters, and inside 95.412 square meters. The heating surface of the fire tubes outside and inside, respectively, is 97.568 square meters and 87.752 square meters. The rack driving wheel on this engine is 0.955 meter in diameter, while the six coupled driving wheels are 1.015 meter.



Four-cylinder Compound Adhesion and Rack Locomotive. Weight in Working Order, 45 tons

The front and middle driving wheels carry 12 tons each, and the rear driving wheels 11.78 tons. The trailing wheels each have a diameter of 0.738 meter, and they carry a load of 9.56 tons. The total wheel base is 4.95 meters.

* * *

In an article in the *Iron Trade Review*, Mr. O. M. Becker compares the efficiency of high-speed steel milling cutters with those of carbon steel. It is stated that in experiments undertaken, a high-speed steel cutter would cut at a surface speed of 82 feet per minute with a table travel of 27 inches per minute, milling 6,800 linear inches before regrinding. The best results obtainable under the same conditions with a carbon steel cutter were 1,300 linear inches before regrinding with a table feed of 15 inches per minute. The carbon steel cutter required five grindings during the time the high-speed steel cutter required to be ground but once. Besides, it is pointed out that the life of a high-speed steel cutter outlasts the carbon steel cutter from 5 to 20 times. In view of the fact that doubts have been expressed as to the value of high-speed steel for milling cutters, these reports of actual experiments are of considerable interest and importance.

* * *

Attention is called in the *Scientific American* to the fact that the Walschaerts valve gear was in use in this country as early as 1864. In that year the Lehigh Valley R. R., in taking over the plant of a smaller road which it had absorbed, secured two locomotives built by the Niles Locomotive Works of Cincinnati, which were equipped with the Walschaerts valve gear. The idea that the Walschaerts valve motion is of recent origin is erroneous. It has been in use in Europe continuously for the last fifty years, although it has but recently been introduced on a large scale in this country.

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COMPRESSOR DESIGNING—THE DISTRIBUTION OF THE LOAD

FRANK RICHARDS*

The air compressor shown in Figs. 1 and 2 may be regarded as a standard machine for the special line of work for which it is adapted. There is that which is picturesque for the engineer as well as for the landscape gardener, and this is a picturesque and interesting machine, embodying a number of details of ingenious design which are well worth considering. The compressing of air is not in any case as simple an operation as the pumping of water, and when high pressures are required, involving, as in this case, multiple stage compression, the problem of equitably apportioning the work and the effect for each step of the operation, the providing for the easy flow and the efficient cooling of the air between the stages, the reduction of machine friction to a minimum, the providing for the proper lubricating of all the working parts, the arranging of all for ready accessibility when wear or accident makes it necessary, constitute in all an intricate problem, the solution of which is well worth looking into. Nothing, of course, is final, and everything achieved is a challenge to surpass it, so that doubtless later there may be a better machine than this, or than any we now know of, and we must note its points of excellence while we may.

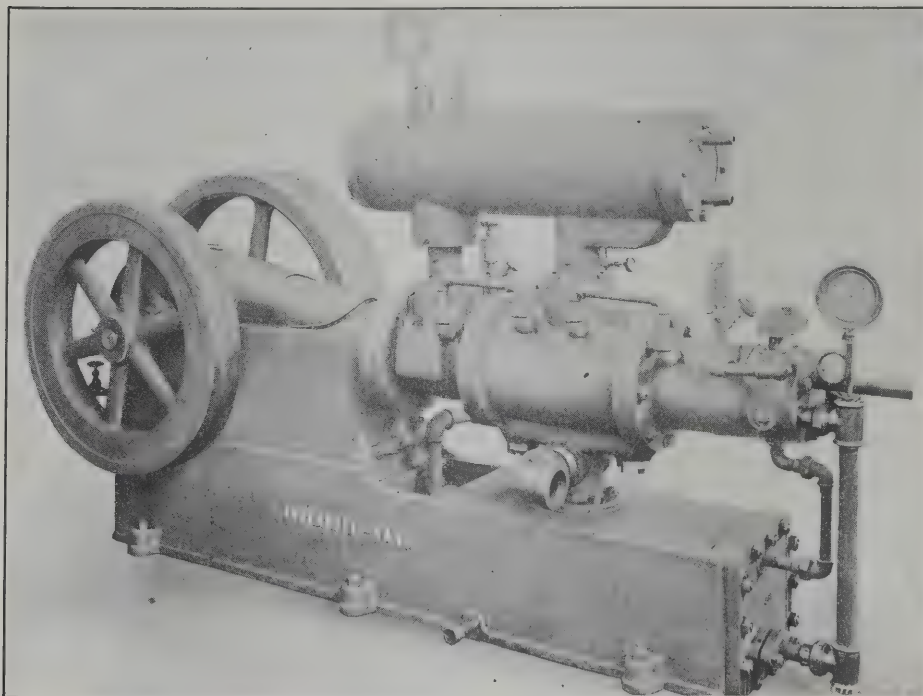

Fig. 1. Ingersoll-Rand Three-stage Air Compressor, designed to compress to 1000 pounds per square inch

This is a three-stage air compressor designed to work to 1,000 pounds gage pressure, with a free air capacity of about 50 cubic feet per minute. It is a power-driven machine, the type of power application being according to circumstances. As here shown it has a pulley for a belt drive, but it may also be driven by a chain, gearing, a Pelton wheel on an extension of the shaft, or by a direct-connected electric motor.

The dimensions of the cylinders are: 8-, 5- and 2⅝-inch diameter, respectively, by 8-inch stroke, and the normal speed is 150 revolutions per minute, giving a piston speed of 200 feet. The low-pressure, or intake, cylinder is double-acting and the other two are single-acting. The three cylinders are in a straight axial line, one piston-rod extending from the crosshead through all the pistons. The low-pressure cylinder is between the other two, the intermediate cylinder being in front, or toward the crank, and the high-pressure cylinder at the back. The pistons of the intermediate and of the high-pressure cylinder are, in fact, plungers on each side of the low-pressure piston. The working area of the low-pressure piston on each side is, therefore, only that portion of the piston which surrounds the plungers, and these areas are quite different on the two sides of the piston on account of the different plunger diameters. This arrangement gets rid of all cylinder heads or partitions and stuffing-boxes between the cylinders. The only stuffing-box for the entire machine is that in the head next to the crosshead and opposed to the working pressure of the intermediate cylinder. The piston rings are the only packings required besides this one stuffing-box. The packing rings for the low-pressure and the inter-

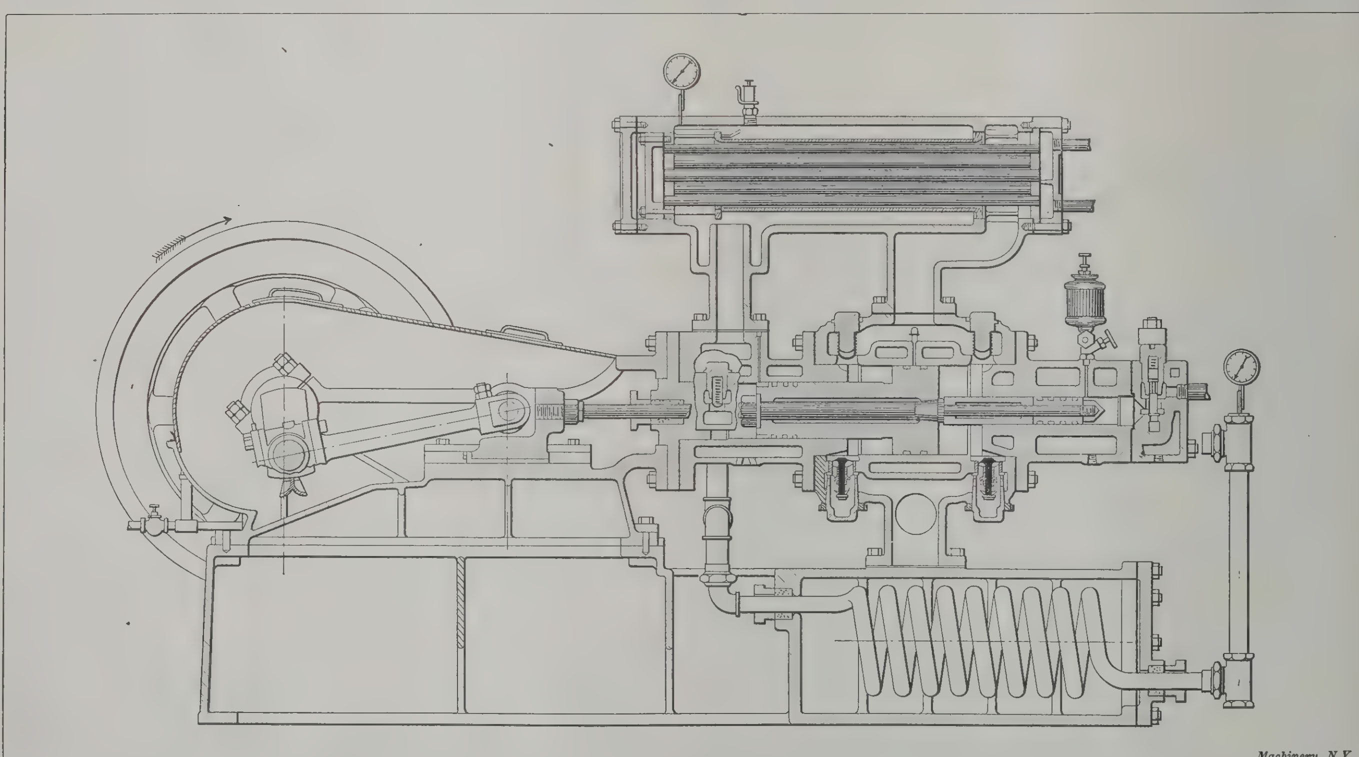

Fig. 2. Sectional View or the Three-stage Air Compressor

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mediate pistons are sprung into grooves turned in the solid metal. In the high-pressure piston or plunger the grooves are not turned in the solid but are formed by removable sections which fit the piston-rod and also the cylinder bore, and which are cut away at the outer corner to form the grooves for the rings. When the main portion of this piston is in place in the cylinder, a packing ring is slipped in to fit against it; one of the movable sections of the piston is then slipped in against this, then another ring, then another piston section with a washer and nut outside, which secures all. The middle or low-pressure piston has a taper fit on the rod, and is secured by a nut outside the intermediate plunger, which thus locates it precisely and holds it securely.

The actual working clearances of one of these compressors, as determined by the inspector, were: for the low-pressure cylinder, 3/32 inch and 3/32 inch; intermediate cylinder, 1/8 inch; high pressure, 1/8 inch. The distribution of the pressures and the apportionment of the work of compression throughout the cycle of operations of this compressor are such as to make the work for each stroke nearly the same.

On the forward stroke, or with the pistons moving toward the crank, the low-pressure piston and the intermediate piston are both compressing to their respective pressures, and the receiver pressure against the high-pressure plunger is assisting; that is, its thrust at practically constant pressure is to be deducted from the total work done by the other two pistons. On the backward stroke, the low- and the high-pressure pistons are compressing, and the receiver pressure against the intermediate piston is assisting in the work. By calculation based on the assumption that the compression is adiabatic, it is found that the horse-power required for the forward compression stroke of the low-pressure cylinder is 2.79, and for the same stroke of the intermediate cylinder, 8.52 H.P. The total horse-power resistance for the forward stroke is $8.52 + 2.79 = 11.31$ H.P. The intake pressure against the high-pressure plunger which is approximately constant, is sufficient to develop 3.13 H.P. which is to be deducted from the working horse-power of the other two cylinders, giving us as the net horse-power for the forward stroke $11.31 - 3.13 = 8.18$ H.P. For the back stroke of the low-pressure piston the horse-power resistance equals 4.17 H.P., which is, of course, greater than for the forward stroke, because of the increased piston area. The resistance for the working stroke of the high-pressure cylinder equals 8.93 H.P., giving a total for both the low- and high-pressure cylinders of $4.17 + 8.93 = 13.10$ H.P. From this it is necessary to deduct the power due to the intake pressure against the intermediate piston, which is found to be 3.13 H.P. The net power for the back stroke then will be $13.10 - 3.13 + 9.97$ H.P.

While the work of the two strokes is so nearly equal, that of the back stroke is the larger, which is at it should be, as this occurs on the thrust of the connecting-rod instead of on the pull. A sufficient reduction of the terminal delivery pressure would equalize the work for the alternate strokes.

As before stated, adiabatic compression is assumed in each cylinder, with efficient intercooling between the stages. The cylinders are all very completely water jacketed, so that the temperatures of the working surfaces are kept down, and satisfactory lubrication is maintained, but there is little cooling effect upon the body of air in the cylinders during the operation of compression. The circulation of the cooling water is accomplished by a single continuous flow through both intercoolers and all the water-jackets, there being no places where the water can remain without change. The efficiency of the intercooling is sufficiently indicated by the fact that the temperature of the air leaving the second intercooler and entering the last compressing cylinder was found upon a prolonged test to be the same as that of the initial intake or 70 degrees, and the temperature of the air as finally delivered, there being no after cooler, was 188 degrees. The final temperature for perfect adiabatic, single stage compression to 1,000 pounds would be above 1,250 degrees, which would be prohibitive in practice.

This compressor will be found to be an extremely simple one, when the complication of function is taken into consideration.

CALCULATING THE SIZE OF BLANK FOR ROLLING SCREW THREADS

J. F. SPRINGER*

There are some interesting problems connected with screw threads which come into prominence when we take up the question of forming them, not by a cutting operation, but by a rolling process. In the process of thread rolling there is no cutting of the groove; the whole procedure depends upon pressing the metal down at one point and permitting it to protrude at another. There are no chips. The amount of metal with which one begins is the amount with which one ends. When cutting a thread in the lathe, the gage of the thread is the same as the gage of the blank; but this is not the case in thread rolling. The thread here projects out beyond the original surface, so that to make a screw thread of a particular gage, it is necessary to use a blank of less diameter. But how much less? To answer this question, it is necssary to determine just how much material is contained in a screw thread.

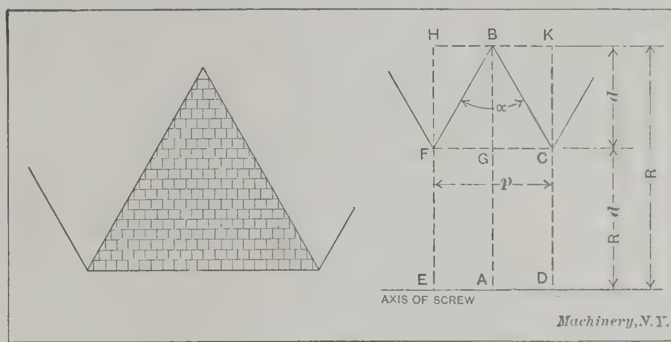

Fig. 1 Fig. 2

Before taking up this question in a mathematical way, it may be well to point out how it might be solved experimentally. Suppose we wish to ascertain the exact volume of a sharp 60-degree V-thread ¾ inch in diameter, 10 threads per inch. Taking a ¾-inch rod of some homogeneous material, we first weigh it accurately. We next cut the required thread in the lathe, and measure the length of rod thus threaded. We may now weigh the rod again. The difference between this weight and the former one is evidently the weight of material removed in forming the groove. To get the weight of the thread itself, we may now turn off the threads and weigh the rod after the threads have been turned off. Still another method of getting the volume of the thread depends upon the fact that the groove and thread combined form a cylindrical shell whose volume may easily be calculated (by subtracting the volume of the cylindrical core from that of the blank before threading). Therefore, when once we have ascertained the volume of groove or thread, the volume of the other may readily be obtained from the combined volume by subtraction. All methods of cutting and weighing, however, require very delicate scales and careful experimentation; besides, they have to be repeated for every size.

It is important, then, to consider how we may approach this subject mathematically. The simplest thread to calculate is the square thread. In this thread the amount of metal removed is exactly the same as that left in the thread. Consequently, to get the volume of either thread or groove, we calculate the volume of the cylindrical shell, between the core of the bolt and the original cylinder of the blank, and then divide by 2. Suppose the diameter of the blank is 2 inches and the depth of thread is 0.2 inch. Then the radius of the blank is 1 inch, and that of the core 0.8 inch. If the length of the threaded portion is 3 inches, we have for the shell:

$\pi \times 1^2 \times 3 - \pi \times 0.8^2 \times 3 = 3.393$ cubic inches.

As thread or groove is one-half the shell, we have, for either, the value 1.697 cubic inch.

If there are eight threads to the inch, then there are altogether in the three inches of length a total of 24 threads. Consequently, the volume of a single thread passing once

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around the screw is $\frac{1.697}{24} = 0.071$ cubic inch.

Now let us consider the case when square grooves and square ridges run around the bolts in planes perpendicular to the axis. Just as before, the volume of the ridges is just equal to that of the grooves, provided that ridges and grooves are the same in section. We must, however, have an equal number of grooves and ridges in order to calculate correctly. In three inches we should have 24 ridges and 24 grooves. Consequently, as before, we find that a single ridge or groove has a volume at 0.071 cubic inch. Consider now what this means. Provided the cross-section is the same in both cases, a square thread has the same volume whether the thread is a ridge in a plane at right angles to the axis or whether it winds as in a screw. This is a very important conclusion, as upon it depends our method for the calculation of other styles of threads. It does not matter, then, how much or how little a square screw thread is inclined, its volume is ever the same, provided no change in the axial section is made. To determine its volume, accordingly, we take it in its easiest position—that is, when it is a plain annular band. We can easily calculate this, by finding the volume of a cylinder whose base has the same diameter as the thread and whose height is one-half the pitch. From this we subtract the volume of the cylinder whose height is one-half the pitch and whose diameter is that of the thread less twice the depth of the thread. The difference between these two volumes will be the volume of one thread passing once around the screw. Let $2R$ be the diameter of the original blank, p the pitch, and d the depth of thread. If we denote the volume of one convolution of square thread by V, we may write

$$V = \frac{1}{2}\left[\pi R^2 p - \pi (R-d)^2 p\right] = \frac{1}{2}\pi p\,(2Rd - d^2) \quad (1)$$

Let us now inquire whether this principle that the volume of a convolution is independent of the inclination of the thread is true for the ordinary V-thread. In Fig. 1 is represented in axial section a 60-degree V-thread. We may divide this triangle by a series of lines all parallel to the base and equally distant from one another. We further divide the several bands into which the triangle is thus divided by vertical lines

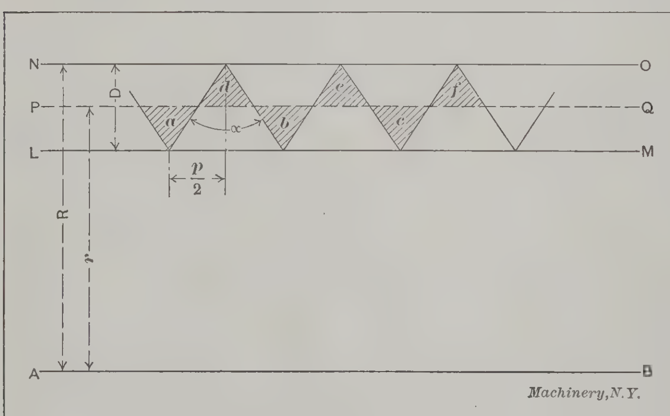


Fig. 3

into small squares all equal to each other. We have as the result a multitude of square screw threads. With the exception of the helical strips, one at the summit and one at each end of a row of squares, the cluster of little square threads will make up the large V-thread.

We now proceed to reduce the size of the section of the little square threads. Each one is made smaller, but each is kept square and all are kept equal. To do this, all we have to do is to draw all the lines closer together. The sum of the squares is now more nearly equal to the V-section, and the cluster of the small square threads becomes more nearly equal to the V-thread. If we continue to make the squares smaller, we get closer and closer to the V-section, and the cluster of square threads gets closer and closer to the V-thread. As there is no limit to our process of reducing the squares and, therefore, no limit to the closeness with which the resulting cluster of square threads approximates the V-thread, we conclude that the rule for square threads holds for the full V-section and the full V-thread. That is to say—we conclude that the volume of a V-shaped convolution may be found by ascertaining that of an annular ring having the same V-section. This is a very important conclusion.

A little consideration will soon convince one that precisely the same rule applies to any style of thread. For, by the same system of approximation, we may reach the same result.

Let us now derive the formula for the volume of a sharp V-thread. In Fig. 2, let a be the angle of the thread, p the pitch, d the depth, and R one-half the outside diameter. We must calculate the volume of an annular ring having the triangle BCF as its axial section. The volume of the annular ring may be determined by adding together the two conical frustums generated by rotating $ABCD$ and $ABFE$ on ED as axis and then subtracting the cylinder generated by rotating $FCDE$ on the same axis. We may write:

Frustum $ABCD =$

$1/3 \times 1/2\, p\, [\pi R^2 + \pi (R-d)^2 + \pi R (R-d)]$.

Frustum $ABFE =$

$1/3 \times 1/2\, p\, [\pi R^2 + \pi (R-d)^2 + \pi R (R-d)]$.

Cylinder $FCDE = p\,\pi\,(R-d)^2$.

Consequently, denoting the volume of the convolution of the screw thread by W, we have

$$W = \frac{p\pi}{6}[R^2 + (R-d)^2 + R(R-d)] + \frac{p\pi}{6}[R^2 + (R-d)^2 + R(R-d)] - p\pi (R-d)^2$$

$$= \frac{p\pi}{6}[2R^2 + 2(R-d)^2 + 2R(R-d) - 6(R-d)^2]$$

$$= \frac{p\pi}{6}[2R^2 + 2R^2 - 4Rd + 2d^2 + 2R^2 - 2Rd - 6R^2 + 12Rd - 6d^2]$$

$$= \frac{p\pi}{6}[6Rd - 4d^2],\quad W = \frac{p\pi}{3}[3Rd - 2d^2)$$

$$= \frac{pd\pi}{3}[3R - 2d] \quad (2)$$

We may put this formula in a different form. By referring to Fig. 2, we may write

$$\tan\frac{a}{2} = \frac{GC}{BG} = \frac{\frac{1}{2}p}{d} = \frac{p}{2d}, \text{ or } p = 2d\tan\frac{a}{2}.$$

Substituting this in equation (2), we get

$$W = \frac{2d^2\pi\tan\frac{a}{2}}{3}[3R - 2d] \quad (3)$$

Since $\tan 30° = \frac{\sqrt{3}}{3}$, we have for the sharp 60-degree thread:

$$W_1 = \frac{2d^2\pi\, 1/3\sqrt{3}}{3}[3R - 2d]\,.$$

$$= \frac{2\sqrt{3}}{9}d^2\pi\,[3R - 2d] \quad (4)$$

Now, just as we found the volume of a convolution of the thread by adding two frustums and then subtracting a cylinder, so we may proceed with the calculation of the volume of a convolution of the thread groove. But we may take a different course; we observe that a thread convolution plus one of its adjacent groove convolutions has a volume equal to that of an annular ring whose axial section is the sum of those of thread and groove. By taking one-half of one adjacent groove and one-half of the other, we may reduce the annular ring to a cylindrical ring whose axial section is $FCKH$ (Fig. 2). The volume of this ring is obtained by subtracting the cylinder formed by rotating $EFCD$ from that formed by rotating $EHKD$. That is, the volume of the ring is $p\,\pi\,R^2 - p\,\pi\,(R-d)^2 = p\,\pi\,(2Rd - d^2) = p\,d\,\pi\,(2R - d)$. If we subtract from this the volume of the thread (equation 2), we get for the volume X of a convolution of the V-shaped thread groove,

$$X = p\,d\,\pi\,(2R - d) - \frac{p\,d\,\pi}{3}(3R - 2d)$$
$$= \frac{p\,d\,\pi}{3}(3R - d) \quad (5)$$

Since $p = 2\,d\tan\frac{\alpha}{2}$

we have

$$X = \frac{2\,d^2\,\pi\tan\frac{\alpha}{2}}{3}(3R - d) \quad (6)$$

For the sharp 60-degree thread, we have

$$X_1 = \frac{2\sqrt{3}}{9}\,d^2\,\pi\,(3R - d) \quad (7)$$

It is interesting to note that with V-shaped threads, where the grooves have equal but inverted sections, the volume of a groove convolution is greater than that of a thread convolution. Thus the groove convolution is (formula (5))

$$\frac{p\,d\,\pi}{3}[3R - d]$$

and the thread convolution (formula (2))

$$\frac{p\,d\,\pi}{3}(3R - 2d)$$

The first value is greater than the second. By subtracting, we ascertain that the excess of groove over thread is $\frac{p\,d^2\,\pi}{3}$.

In rolling a screw thread, a sharp ridge is pressed into the blank. As the metal being operated upon is not easily compressible, particles move away from the advancing tool, penetrating, under the pressure applied, into the body of the blank; but they cannot coalesce with the particles against which they press; nor can they sensibly find room through compression. Thus it comes about that a sharp ridge pressed into a steel blank accomplishes two results. First, it makes an indentation or groove. Second, it forms, indirectly, two adjoining ridges with a groove between them. Without going further into the process of thread rolling, enough has been said to make it clear that in threading a blank, the lower part of the groove is made by pressing suitable tool edges into the blank, and the upper part of the thread is due to material forced up out of the blank. Disregarding minute quantities, this bottom portion of the groove must equal in volume the extruded material. In Fig. 3, *AB* is the axis of the blank, *PQ* represents its original surface, *LM* marks the depth to which there is actual penetration of the forming dies, and *NO* defines the height to which there is extrusion of material. The problem that has to be solved is to determine $2r$, the diameter of the blank, when $2R$, the diameter of the desired screw, is given. The volume, then, of the grooves *a*, *b*, *c*, etc. must just equal the volume of the threads *d*, *e*, *f*, etc. By formula (3) we may express the volume of a convolution of the thread *def*. We replace d in this formula by its equivalent $R - r$, and obtain volume of thread convolution e (see Fig. 3).

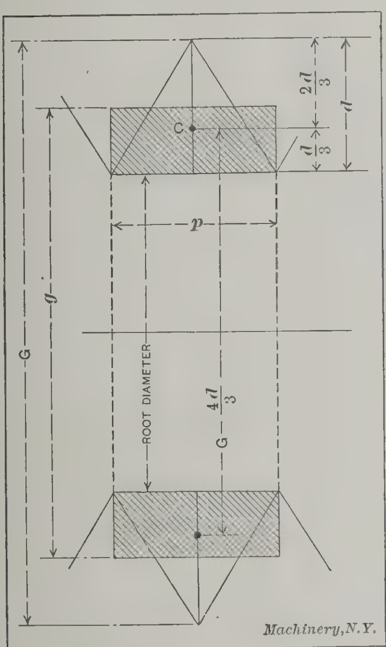


Fig. 4

$$e = \frac{2\,(R - r)^2\pi\tan\frac{\alpha}{2}}{3}(R + 2r)$$

Similarly, by formula (6) we may express the volume of a convolution of the groove b; we must, however, replace R in this formula by r, and d by $D + r - R$ (see Fig. 3). We then have:

Volume of groove convolution

$$b = \frac{2\,(D + r - R)^2\,\pi\tan\frac{\alpha}{2}}{3}(2r - D + R)$$

Now thread convolution e must be equal to groove convolution b.

$$\frac{2\,(R - r)^2\,\pi\tan\frac{\alpha}{2}}{3}(R + 2r) = \frac{2(D + r - R)^2\,\pi\tan\frac{\alpha}{2}}{3}(2r - D + R)$$

or $(R - r)^2\,(R + 2r) = (D + r - R)^2\,(2r - D + R)$.

From this we get, after performing the operations indicated and collecting

$$3\,Dr^2 = D^3 - 3\,D^2R + 3\,D\,R^2.$$

Dividing by $3\,D$,

$$r^2 = \frac{D^2 - 3\,D\,R + 3\,R^2}{3}$$

$$r = 1/3\,\sqrt{3\,(D^2 - 3\,D\,R + 3\,R^2)}. \quad (8)$$

It will, perhaps, be more convenient to have this formula in terms of R and p instead of in terms of R and D. Referring to Fig. 3, we see at once that

$$D = \frac{p}{2}\cot\frac{\alpha}{2}$$

Replacing, by means of this value, the quantity D in formula (8), we get,

$$r = 1/3\sqrt{3\left(\frac{p^2}{4}\cot^2\frac{\alpha}{2} - 3/2\,Rp\cot\frac{\alpha}{2} + 3\,R^2\right)}$$

$$r = 1/6\sqrt{3\left(p^2\cot^2\frac{\alpha}{2} - 6\,Rp\cot\frac{\alpha}{2} + 12\,R^2\right)}$$

If $\alpha = 60$ degrees, then $\cot\frac{\alpha}{2} = \sqrt{3}$,

and we get,

$$r = 1/6\sqrt{3\,(3\,p^2 - 6\,\sqrt{3}\,R\,p + 12\,R^2)}$$

$$r = 1/2\sqrt{p^2 - 2\sqrt{3}\,R\,p + 4\,R^2} \quad (10)$$

Formula (10) applies to the ordinary sharp V-thread of 60 degrees. The value $2r$ would be the diameter of wire that should be used on a thread rolling machine to produce a screw thread of an external diameter equal to $2R$. Let g be the diameter of blank wire and G the diameter of the finished screw thread. Then we may write,

$$g = \sqrt{p^2 - G\,p\,\sqrt{3} + G^2}. \quad (11)$$

* * *

The result of the working of storage battery motor cars on the Prussian state railways has proved so satisfactory that fifty-seven new cars have been ordered. The new cars are of a double-unit type, consisting of two four-wheeled cars, coupled together, having a total capacity of one hundred passengers The storage batteries in the new cars are not to be placed under the seats as in the previous cars, but located in a compartment projecting beyond the engineer's cabin. These cars are intended for suburban service, and a maximum speed of 50 kilometers (31 miles) is to be attained.

* * *

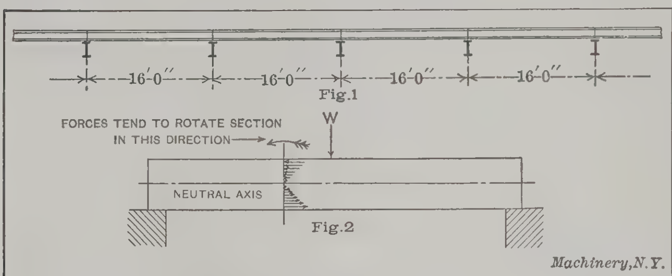
The railroad commission of Nebraska is reported to have ruled that any passenger on any train may ride in Pullman cars without paying an extra charge as long as no seat is vacant in the ordinary coaches. This is in accordance with the practice in several European countries where any passenger is entitled to ride in the next higher class accommodation than the one for which he has paid, if seating accommodations cannot be provided for him in this latter class.

SPLICES FOR I-BEAMS AND CHANNELS*†

A. L. CAMPBELL‡

It often happens, in the use of rolled shapes for structural purposes, that the material could be spliced together conveniently and with economy, provided an efficient and reliable form of splice were available.

For example, Fig. 1 shows a side elevation of a long row of floor beams, supported every sixteen feet. In such a case the row of beams is usually made up of sixteen-foot lengths, supported on the cross beams, and with little or no connection between their ends. If the floor load is uniformly distributed, the maximum bending moment in the floor beams will be $\frac{WL}{8}$ at mid-span, where W is the total load on the beam per panel, and L is the panel length. Now, assume that the row of floor beams is shifted bodily eight feet to the left or the right, so that the beams will be continuous over the supports, with the ends butting together at mid-span; then, if the ends were efficiently spliced together, we would have a continuous floor beam, with maximum bending moments of $\frac{WL}{12}$ at the supports, and $\frac{WL}{24}$ at the splices. Thus, the bending moment in the floor beams is a maximum where their gross section is available to resist it, while the bending efficiency of the splice at mid-span need be only 50 per cent of the maximum.



Figs. 1 and 2. Diagrams for Calculations of Splices for I-beams

With the second arrangement the floor will safely carry a load 50 per cent greater than it would with the first, or for the same load only two-thirds as much material need be used in the floor beams. Long ties, etc., might also be made up of two or more pieces, with splices, thus saving double freight charges for shipping long pieces.

Splices for I-beams and channels have been calculated in the following, and the splices for the I-beams are also shown in the accompanying Supplement. The sections are taken from Carnegie's Hand-book, and a medium section of each size has been chosen. The calculations may, however, be readily applied to any desired section. In every case the splices for I-beams and channels consist of a top and bottom plate, or plates, riveted to the flanges, and two side plates riveted to the web.

The reason why medium-sized sections have been selected for the calculations, rather than the so-called standard sections, is that the medium-sized section more nearly fulfills the average requirements in design, and as the steel mills constantly roll other than the standard sections, they can be obtained without difficulty. An inspection of a table of steel shapes reveals the fact that the standard section is usually the lightest section rolled of any one size, and has a very thin web. If a short standard section be used as a beam, the load, which will produce a fiber stress of 16,000 pounds per square inch in a beam, will greatly overload the web of the beam over the supports, when it acts as a compression member. If one or more of these light sections be used as columns or struts their strength is limited to the crippling strength of their webs. For these reasons the engineering department of the firm where the writer is employed has adopted the medium weights of I-beams and channels as standard sections for average designs.

Having assumed a section to be spliced, it is first necessary to find what proportion of the total area of the section exists in the flanges, and what is contained in the web. Then the splice is so proportioned that the strength of the beam will be, at that point, as nearly as possible equal to what it would be if no splice existed in it. The method of procedure when designing the splice will be illustrated in the following computations, in which the working stresses are assumed as follows:

Tension and compression, 16,000 pounds per square inch.
Shear, 10,000 pounds per square inch.
Bearing, 20,000 pounds per square inch.
Double shear is equivalent to 1.8 single shear.

Splice for 24-inch 90-pound I-beam (See Supplement)

Area of section, 26.47 square inches.
Thickness of web, 0.631 inch.
Width of flange, 7.131 inches.
Tangent of web, 20.75 inches (depth of flat portion of web).
Grip of rivet, 27/32 inch (depth of rivet holes in flanges measured on center line of holes).
Sectional modulus of section, 186.6 (neutral axis perpendicular to web).

As shown in the Supplement, the rows of rivets in the web are 2½ inches apart; thus each row may be regarded as carrying a load equal to the stress in a strip of the web extending 1¼ inch above and below its center line. Since the distance from the top row to the bottom row of rivets is 18¼ inches, the portion of the web upon which the web rivets of the splice will be effective is 18¼ + 1¼ + 1¼, or 20¾ inches, and the sectional area of this portion is 20¾ × 0.631, or 13.09 square inches. The area of the section to be cared for by the rivets in each flange, or the sectional flange area, is then $\frac{26.47 - 13.09}{2}$ or 6.69 square inches.

Having now found the flange and web areas of the above section, it is only necessary to so proportion the rivets in the splice that the existing fiber stresses in the beam may be transferred into the splice plates, and to provide ample metal in these plates to prevent excessive fiber stresses in them.

The net section of a strip of the web 2½ inches wide (one 15/16-inch hole deducted) is (2½ — 15/16) × 0.631 = 0.99 square inch, and the allowable tension on this strip will be 0.99 × 16,000 = 15,840 pounds. Allowable double shear of a ⅞-inch rivet = 1.8 × 6,010 = 10,818 pounds, while its bearing value in the web is ⅞ × 0.631 × 20,000 = 11,060 pounds. The number of rivets required in the web plates for each strip is therefore 2.

The net section of the flanges will be 6.69 — 2 × 27/32 × 15/16 = 5.11 square inches, and the allowable stress on this area will be 5.11 × 16,000 = 81,760 pounds. The number of ⅞-inch rivets in single shear required to transmit this stress to the flange plates is 14. The web plates should have a combined thickness greater than the thickness of the web, so two ⅜-inch plates are used. In like manner two ½ × 7⅛-inch plates will have a combined net area of 5.25 square inches, and may be used on both flanges.

The sectional modulus being 186.6, the maximum allowable bending moment in a beam of this section is 186.6 × 16,000 = 2,985,600 inch-pounds. At first, 14 rivets only are calculated for on each side of the center of the splice, in the flanges. Taking moments about the neutral axis of the beam and splice, for the rivets above or below this axis, we obtain the resisting moment for this portion of the rivets as follows:

$$14 \times 6{,}010 \times 12 = 1{,}009{,}680 \text{ inch-pounds.}$$

$$2 \times \frac{73}{96} \times 10{,}818 \times 9\tfrac{1}{8} = 150{,}128 \text{ inch-pounds.}$$

$$2 \times \frac{53}{96} \times 10{,}818 \times 6\tfrac{5}{8} = 79{,}130 \text{ inch-pounds.}$$

$$2 \times \frac{33}{96} \times 10{,}818 \times 4\tfrac{1}{8} = 30{,}679 \text{ inch-pounds.}$$

$$2 \times \frac{13}{96} \times 10{,}818 \times 1\tfrac{5}{8} = 4{,}758 \text{ inch-pounds.}$$

Total resisting moment 1,274,375 inch-pounds.

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* See also article entitled "Beam Formulas," MACHINERY, September, 1905, engineering edition, and MACHINERY'S Data Sheet No. 48, Stresses and Deflections in Beams, Shafts, etc.
† With Data Sheet Supplement.
‡ Assistant Construction Engineer, The Solvay Process Co., Detroit, Mich.

The fractions whose denominators are 96 represent the ratios of the distances from the neutral axis, of the different rows of web rivets, and the product of this fraction multiplied by 10,818 is the actual working load of any one web rivet, when the flange rivets have assumed their maximum allowable load.

Since the forces producing tension and compression in the beam below and above the neutral axis tend to cause rotation in the same direction (see Fig. 2), the resisting moment of all the rivets on one side of the splice is twice the above amount, or 2,548,750 inch-pounds. The resisting moment

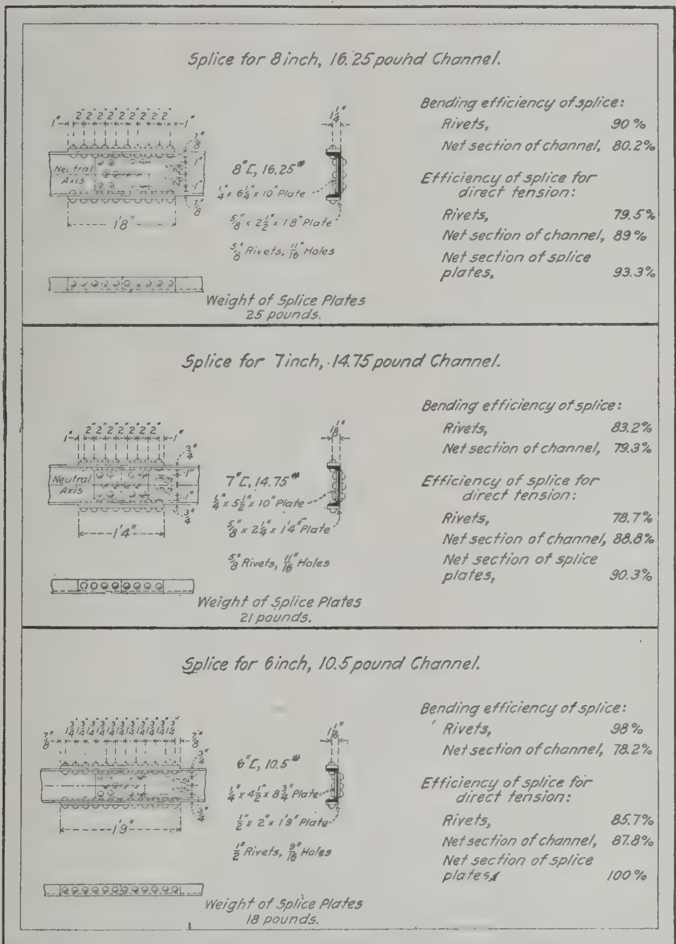

Fig. 3. Splices for 6-, 7- and 8-inch Channels

being always equal to the bending moment, the bending efficiency of the above splice with respect to the rivets is

$$\frac{2,548,750}{2,985,600} = 85.4 \text{ per cent.}$$

The point of minimum bending efficiency of the beam at the splice will be found at section AA, two rivet holes being here deducted from each flange. The transverse sectional area of these two rivet holes is 1.58 square inch, and the distance from the center of gravity of this area to the neutral axis of the beam is about 11⅝ inches. The bending efficiency of the beam at section AA is therefore

$$\frac{2,985,600 - 2 \times 1.58 \times 16,000 \times 11\tfrac{5}{8}}{2,985,600} = 80.4 \text{ per cent.}$$

Since the minimum efficiency of the splice is the effective one, it is desirable to increase the strength of the beam by a rearrangement of the flange rivets. If one rivet is omitted from each flange at section AA, the bending efficiency of the beam will be increased, but that of the rivets in the splice will be reduced to 80.6 per cent. It therefore becomes necessary to leave two rivets in each flange at this point and add one extra rivet, as shown. Fifteen rivets are now effective in each flange, and the rivet efficiency for bending is 90 per cent. The least bending efficiency of the beam will still be found at section AA, and amounts to

$$\frac{2,985,600 - 2 \times 1.58 \times 16,000 \times 11\tfrac{5}{8} + 2 \times 6,010 \times 12}{2,985,600} = 85.2$$

per cent.

If the above spliced beam is placed upon supports at the ends in such a manner that the splice does not come exactly in the center between the supports, but so that the section AA comes between the center of the splice and the middle of the beam and yet is not more than 85.2 per cent of half the span from one of the supports, then, if loaded in the middle, this beam will be able to carry the same load as it would carry if the beam were in one piece. It is easily seen that for most, if not all, conditions of loading the above beam, the splice may be so located that the beam will be as strong as though no splice existed in it.

This splice is excellent for direct tension also. The point of minimum efficiency for a net section of the beam will be found at section AA, and will be

$$\frac{26.47 \times 16,000 - 2 \times 1.58 \times 16,000 + 2 \times 6,010}{26.47 \times 16,000} = 91.2 \text{ per}$$

cent.

The efficiency of the rivets will be, with fifteen ⅞-inch rivets in single shear in each flange, and sixteen ⅞-inch rivets in double shear in the web,

$$\frac{30 \times 6,010 + 16 \times 10,818}{26.47 \times 16,000}, \text{ or } 83.7 \text{ per cent.}$$

The net section of the splice plates will have an efficiency, along the innermost row of rivets, equal to

$$\frac{2 \times \tfrac{3}{8}\,[6(2\,13/16 - 15/16) + (3\tfrac{1}{4} - 15/16) + (2 \times 1\tfrac{1}{4} - 15/16)] + 2[7\tfrac{1}{8} - 2 \times 15/16]}{26.47} = 82.4 \text{ per cent.}$$

In the design of this splice it has been assumed that the ends of the spliced beam do not butt tightly together. If

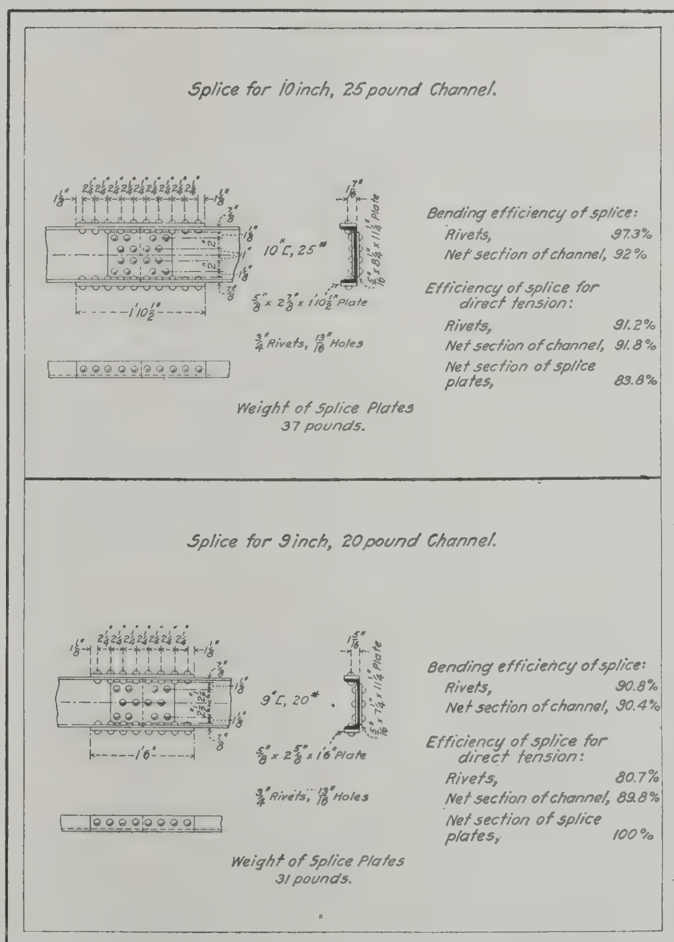

Fig. 4. Splices for 9- and 10-inch Channels

these ends were fitted together perfectly no splice plates would be needed on the compression half of the beam. Since a perfect bearing is impossible, at least the two web plates should extend to the top of the beam. The top flange plates may, however, be safely omitted when the ends are well butted together and a floor plate is riveted to the top flange.

Splice for a 20-inch 80-pound I-beam (See Supplement)
Area of section, 23.73 square inches,
Thickness of web, 0.6 inch,
Width of flange, 7.0 inches,
Tangent of web, 16.5 inches,
Grip of rivets, 29/32 inch,
Sectional modulus of section, 146.7.
Gross web area $= 16.5 \times 0.6 = 9.9$ square inches.

$$\text{Gross flange area} = \frac{23.73 - 9.9}{2} = 6.92 \text{ square inches.}$$

The net flange area $= 6.92 - 2 \times 15/16 \times 29/32 = 5.22$ square inches, and the allowable tension on this area is $5.22 \times 16{,}000 = 83{,}520$ pounds. The number of rivets required is

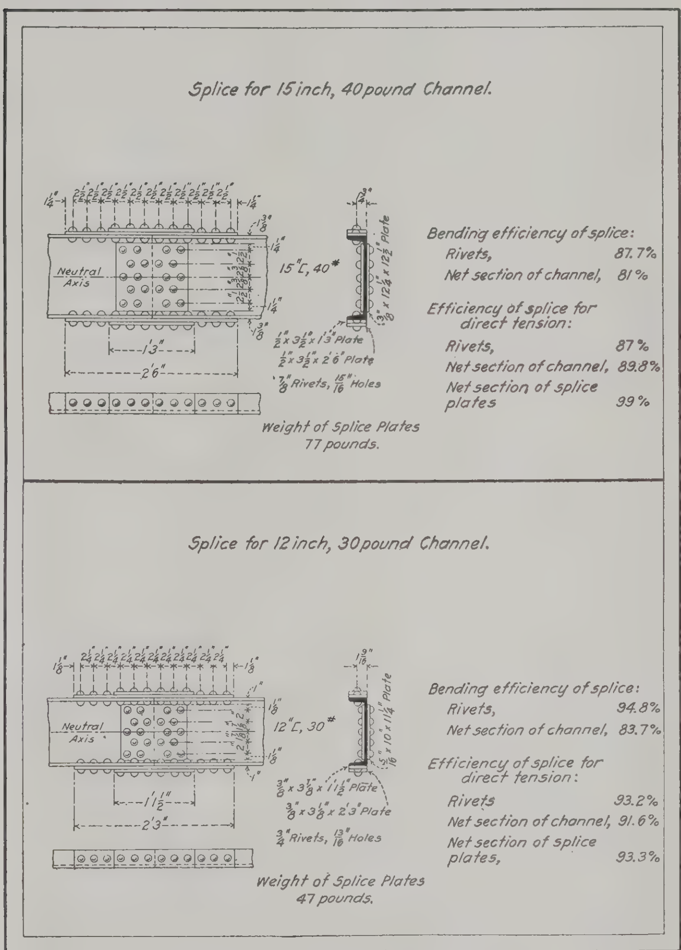

Fig. 5. Splices for 12- and 15-inch Channels

fourteen, but from the computations already made for the 24-inch I-beam it is seen that this number actually ought to be fifteen. Use one $\frac{5}{8} \times 7$-inch plate, and one $\frac{1}{2} \times 7$-inch plate, for each flange, and two $\frac{3}{8}$-inch web plates. As in the preceding case, each row of web rivets should contain two rivets.

The total resisting moment (twice the moment of the rivets above or below the neutral axis) of the rivets on one side of the splice is

$$\begin{aligned} 2 \times 15 \times 6{,}010 \times 10 &= 1{,}803{,}000 \text{ inch-pounds,} \\ 2 \times 2 \times 7/10 \times 10{,}500 \times 7 &= 205{,}800 \text{ inch-pounds,} \\ 2 \times 2 \times 9/20 \times 10{,}500 \times 4\tfrac{1}{2} &= 85{,}050 \text{ inch-pounds,} \\ 2 \times 2 \times 1/5 \times 10{,}500 \times 2 &= 16{,}800 \text{ inch-pounds,} \end{aligned}$$

Total resisting moment, 2,110,650 inch-pounds.

Note.—10,500 pounds is the bearing value of a $\frac{7}{8}$-inch rivet in the web. This amount is less than that of double shear.

The bending efficiency of the rivets is $\dfrac{2{,}110{,}650}{146.7 \times 16{,}000} = 90$ per cent.

The minimum bending efficiency of the net section of the beam will be found at section *BB*, two rivet holes being here deducted from each flange. The efficiency will be

$$\frac{2{,}347{,}200 - 2 \times 1.7 \times 9\tfrac{5}{8} \times 16{,}000 + 2 \times 10 \times 6{,}010}{2{,}347{,}200} = 82.8 \text{ per cent.}$$

When this splice is used in a tension member, the weakest part of the beam is at section *BB*, and the efficiency is

$$\frac{23.73 \times 16{,}000 - 2 \times 1.7 \times 16{,}000 + 2 \times 6{,}010}{23.73 \times 16{,}000} = 88.8 \text{ per cent.}$$

The rivet efficiency will be

$$\frac{30 \times 6{,}010 + 12 \times 10{,}500}{23.73 \times 16{,}000} = 80.7 \text{ per cent.}$$

The efficiency of the net section of the splice plates will be

$$\frac{2 \times \frac{3}{8}[4(2\,13/16 - 15/16) + (4 - 15/16) + (2 \times 1\tfrac{1}{4} - 15/16)] + 2\,[\,(7 - 2 \times 15/16) \times 1\tfrac{1}{8}]}{23.73} = 86.7 \text{ per cent.}$$

Splices for channels are designed in exactly the same manner as those for I-beams, so an explanation of details is unnecessary. It will be noticed, however, in the accompanying engravings, that the flange rivets are not located on the regular gage lines of the channel flanges, but as nearly as possible in the middle of the flange plates. This was done to avoid eccentric loads in these plates.

In the accompanying Data Sheet Supplement are shown splices for I-beams of various sizes, and in the accompanying illustrations are shown the splices for channels. The efficiency of the riveting, net section of the beam, etc., are also given in percentages.

Splices are not shown for I-beams and channels smaller than the 6-inch sections, because it is not often necessary to splice such small pieces; also, the efficiency of the splice would probably be low. The efficiencies of the above splices may be increased by modifying their details. For instance, it will be noticed that usually the least efficiencies are for the net section of the beam for bending, and for direct tension; and the rivet efficiency for direct tension. These values may be increased by using smaller flange rivets, and more of them. In general it may be said that the minimum efficiency of any of the above splices may be made as high as 85 per cent. Only one size of rivet is here used, however, since it is desired to make the details of these splices conform to standard practice as much as possible.

The writer has been unable to find any published data concerning the splicing of structural shapes; he has devised the above method of analysis and furnished designs of splices, with the hope that it may be of some use to others.

In conclusion, it is regretted that none of the above splices have ever been tested to destruction, so that no experimental data are available to confirm or disprove the correctness of the above analyses. However, a set of splices very similar to these was designed by the writer, for a large manufacturing firm in the middle West. These splices have been used continuously for the past two years on all classes of work. In no case have they given trouble, or showed signs of weakness, though often loaded to the full capacity of the pieces in which they occur. One of the most prominent examples is a 15-inch 60-pound I-beam, of 27-foot span, supported at the ends and uniformly loaded with about 500 pounds per lineal foot. This beam is spliced in the middle, and has deflected about one-fourth of an inch under the above load. The beam has deflected in a long smooth curve, showing that the bending efficiency of the splice is really high. If the splice were weak in proportion to the rest of the beam, the tension and compression on the bottom and top of the beam would localize at the splice; and the two halves of the beam would deflect as chords intersecting at the splice, instead of as an arc. Another good illustration is a tension member 116 feet long, composed of two 15-inch, 55-pound channels, and a 1 x 12-inch plate, carrying a load of 544,000 pounds at the middle. It contains six splices, all designed by the above methods, and has borne this load for about fifteen months, with no signs of weakness.

* * *

THE BENEFICENT TARIFF

Every family using iron ore, pig iron, scrap iron, steel rails, cash registers, linotypes, typewriters, steam engines, and wood pulp will now be able to buy them for less, and the cost of living will be reduced.—*New York Times.*

A CHAPTER IN THE EARLY HISTORY OF MACHINE TOOLS—2

JOSEPH G. HORNER*

In continuing the discussion of early types of machine tools, we shall take up in the present article the development of drilling and boring machines, the steam hammer, screw-cutting machinery and the primitive forms of gear-cutting and milling machines.

Slot Drilling Machines

Richard Roberts of Manchester is said to have invented the slot drilling machine as well as the slotting machine, but in 1847 Nasmyth designed a slot drilling machine to avoid the labor of cutting grooves by drilling, chipping and filing. The drill was, as now, flat ended with a notch at the center. The machine was provided with a work table having self-acting traverse, the length of which was adjusted by a crank and rod, and a down-feed put on automatically at the end of the stroke. The gain was stated to be ten to one, and a boy or laborer was given the task of attending to it. Nasmyth did not patent it, but "always had an abundance of orders, as it was its own best advertisement."

A Whitworth slot drilling machine of date 1867 is shown in Fig. 11, driven by a cone pulley and shaft at the back of the bed, through miter gears, and sliding horizontal and vertical shafts to the spur gear seen on the top of the spindle. This spindle runs in hardened conical bushings in a sliding octagonal ram. The spindle head is adjustable along the bed by hand to suit the position of the slot or cotter hole in the work. The reciprocating movement of the drill spindle is operated from the small three-speed cone pulleys seen on the bottom slide of the head. The front pulley is keyed to a worm shaft, rotating a worm wheel with a slotted disk, to which is attached a connecting rod, adjustable for length of stroke, the other end of which is fixed to the middle slide. The octagonal ram slide has a cross adjustment by hand, and the octagonal ram itself has a variable automatic and down feed at both ends of the stroke.

Drilling Machines

The drilling machine was early developed into essentially present designs, both fixed and radial. Back geared cone spindles, self-acting and counterbalanced drilling spindles, rack elevated tables and compound movements to tables, may

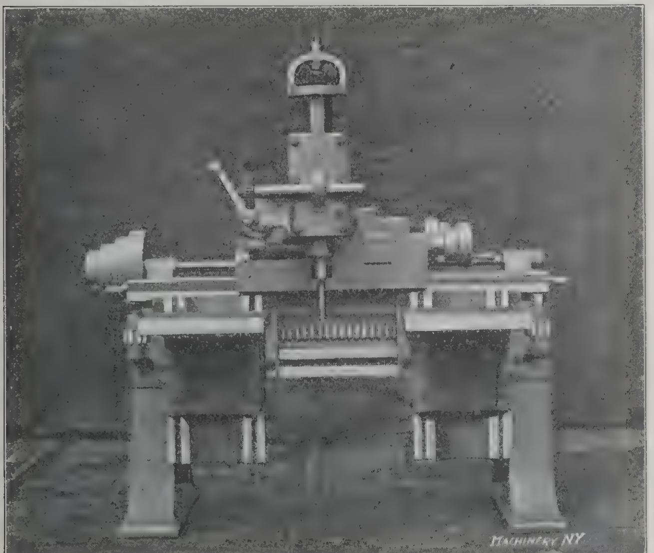

Fig. 11. Slot Drilling Machine, Joseph Whitworth & Co. (1867)

be noted in examples dating from 60 to 70 years back. The framings have a strangely skeleton like appearance, for the box framing had not then come into use.

There were radial drilling machines at Soho, the radial arm being capable of vertical adjustment on a round pillar, by means of a screw. The brackets which carried the pillar were bolted to the wall.

A boring and drilling machine at Soho was double back geared and provided with power and hand feed. It stood 25 feet high, its brackets being bolted to the wall, and the floor plate being movable along a bed 36 feet in length on the floor. It was used largely for boring the beams of the early engines.

In drilling machines made by Whitworth 60 or 70 years ago (Fig. 12) the worm-wheel feed was applied to the drilling spindles. The portion of the spindle above the splined driving bevel wheel and between it and the top bearing was threaded. Two worm wheels located on opposite sides engaged with the screw threads. The worm wheel journals worked in bearings, and the ends were prolonged to be em-

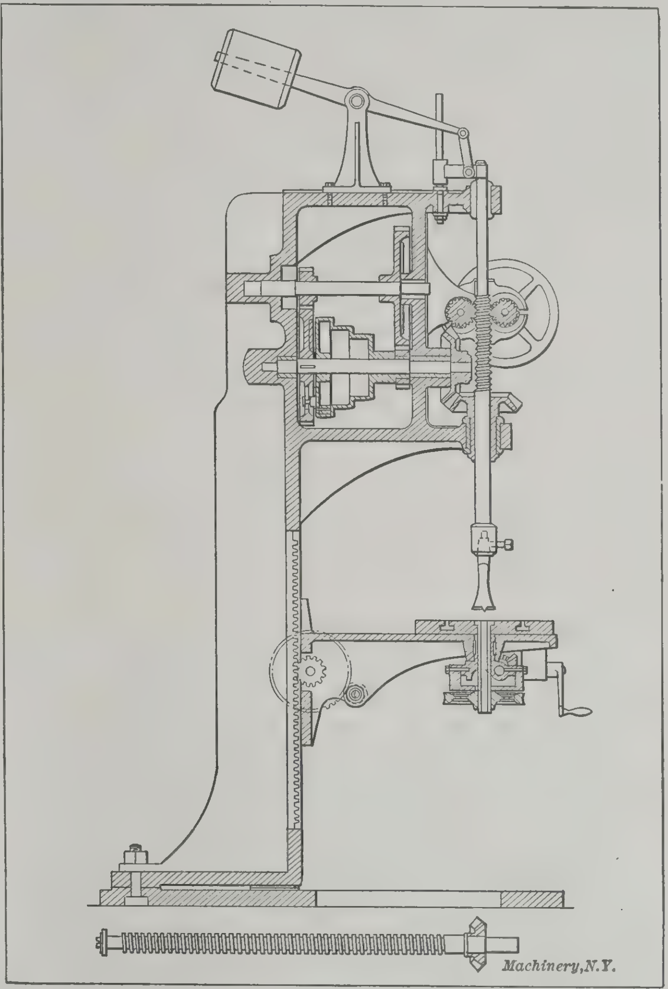

Fig. 12. Vertical Drilling Machine with Screw Feed and Worms Joseph Whitworth & Co. (About 1846)

braced by divided friction clips, Fig. 13, tightened or slackened by a vertical screw. When the clips were tightened so that the worm wheels could not revolve, the spindle screw was fed positively. If the clips were slackened to permit the wheels to slip moderately, the amount of feed was lessened. Probably this graduated feed was too uncertain in its action, but it seems to have been used frequently on radial as well as on fixed machines made by Whitworth.

In the forties we find drilling machines in which the spindle feed is imparted by a treadle and a lever at the top, counterbalanced, pressing the spindle downward by the movement of a bracket sliding on the face of the framing, in which bracket the end thrust was taken.

In the same period the self-acting feed motion through spur gears had been applied by a Mr. Lewis of Manchester to a wall drill. On the spindle above the lower bearing a spur pinion was keyed engaging with a wheel on a feed shaft parallel with the spindle, the driven wheel being engaged or disengaged by a sliding clutch. At the top of the feed shaft a spur pinion engaged with a wheel having its boss threaded to fit a square threaded screw cut on the upper part of the spindle, thus feeding the latter. Hand feed could be substituted for that of power by means of a handwheel on the feed spindle.

Boring Machines

The vertical lathe dates back to the early part of the nineteenth century. It was in use before Bodmer improved it, crystallizing it practically into its present form. The foundation or base carried the spindle on which the circular table

* Address: 45 Sidney Building, Bath, England.

or faceplate was keyed. The tool-box with down-feed motion was carried on a horizontal cross-slide with vertical adjustments on uprights flanking the table. The advantages claimed for it were precisely those claimed to-day.

There were many boring machines both vertical and horizontal in the forties to meet the requirements of the marine engine builders. There were big cylinders in those days, necessary because of the very low pressures adopted, and they were generally bored in vertical machines.

In one of Maudslay's early lathes may be traced the beginnings of the milling and boring machines. The headstock was

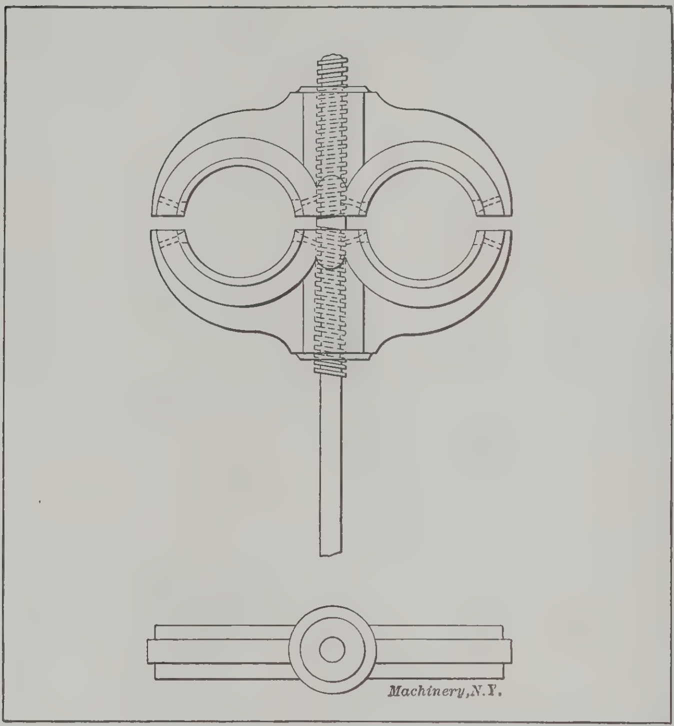

Fig. 13. Friction Collars of Screw Feed Wheel, Whitworth Drilling Machine

provided with a side or lateral traverse by hand or power on a rather long base which would qualify it for milling. Work to be bored was clamped on a table on a bed slide or carriage of large area, the table being raised or lowered on the slide by means of four screws.

A boring machine by Maudslay was already differentiated from the lathe used for boring. The table possessed transverse motion by a screw for boring holes in parallel. The boring bar was capable of vertical adjustment by that movement of its bearings in guides actuated by screws, both driven simultaneously through bevel wheels from a horizontal shaft at the top, just as the cross slide of a planing machine is elevated. The bar was rotated by a five-stepped pulley, grooved for gut band, thence through spur gear to the bar. A screw at the left provided for the horizontal feed of the bar. The feed was put on by power by means of cord-driven pulleys from the bar itself.

Horizontal and vertical boring bars were in existence at Soho. The first was 12 inches diameter, hollow, and having space enough to bore a length of 14 feet 4 inches, and diameter of 4 feet 6 inches. The traversing screw was hand-cut. It was worm-driven, the gear on the end of the bar being a mortise worm-wheel. Differential gears were fitted for feeding the boring head. This machine was made in the period when Murdoch was there, of coal gas fame. There were several boring bars dismantled a few years ago. As Murdoch died in 1839 they must have been built a good while prior to that.

A vertical boring bar 14 inches diameter was the one which bored the cylinders for the screw engines of the *Great Eastern*. This was worm-driven, the gears being below the floor and protected by a plate. The traversing or feed gear was carried on a beam above, built into the wall. These tools were built into the walls and floors as integral portions of the works, and were the precursors of modern tools. Among these ancient machines the dates of which are unrecorded, but which must lie about the period of Waterloo, were lathes, boring machines, wall planers, and others.

After the opening of the Liverpool and Manchester Railway in 1830 there came a great boom in machine tool making. Railways were being constructed all over England between 1830 and 1840, and locomotives and trucks could not be built fast enough. Anything that saved labor was in great demand. The makers of self-acting tools were full of orders. During this period very many great improvements were effected, and the machine tools assumed in several instances nearly their present forms.

Ocean steam navigation was also a potent cause of development, for the marine engines of that time were of massive proportions requiring big boring and planing tools.

Nasmyth Steam Hammer

To this cause the invention of the steam hammer was due. A wrought iron paddle shaft 30 inches diameter was required for the *Great Eastern*, and no firm in England or Scotland would undertake to forge it. Nasmyth was appealed to, and designed his hammer on the essential lines which have survived to the present, except that it fell by gravity only. This was in 1839. The crankshaft was never made, a screw being substituted, and the hammer was allowed to be shelved. In 1842 Nasmyth when on a visit to Creusot saw his hammer at work froging a crank, and learned that the idea had been taken away by a visitor to Patricroft. Then he patented it, and orders came in quickly. Fig. 14 illustrates the first hammer, from a model now in South Kensington Museum.

An offspring of the steam hammer was the steam pile driver, the first two of which were used for the construction of the Keyham Docks, an extension of the Devonport Royal Naval Docks. They were termed steam hammer pile drivers, and were a grand success. A four ton falling weight making eighty blows a minute drove in piles 18 inches square and 70 feet long in 4½ minutes. Previously the same work done by a hand machine had occupied 12 hours.

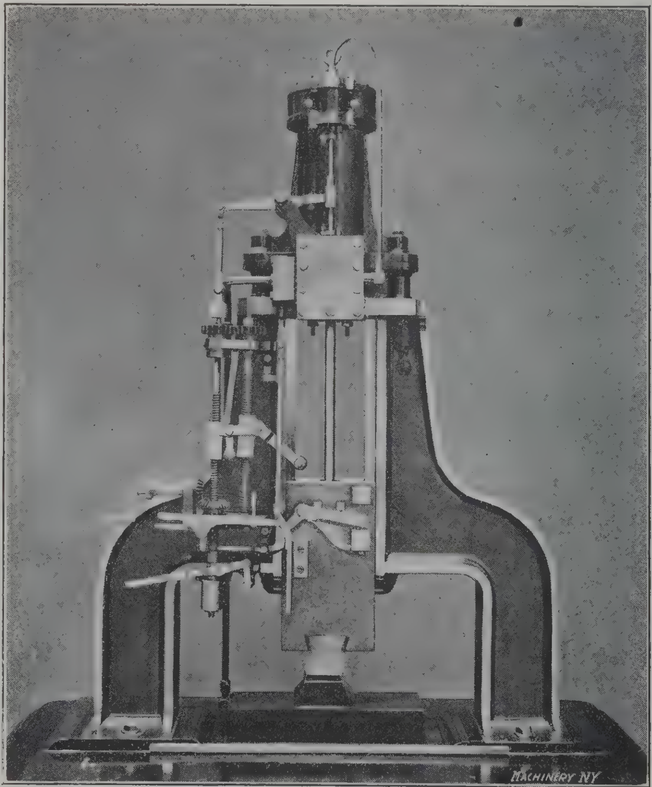

Fig. 14. Model of Nasmyth First Steam Hammer, in South Kensington Museum

When Maudslay began his labors there were no standard screws. Each bolt had its own nut, the two being marked to match. The subsequent work of Whitworth has somewhat eclipsed that of his old master, but he carried on and completed the labors which had engaged the attention of Maudslay from about 1800 to 1835, the time of his death.

Screw-cutting Machinery

One of Maudslay's early devices for originating screws, Fig. 15 (about 1800), and now preserved in South Kensington Mu-

seum, embodied an endless screw and tangent wheel as the essential element. The wheel was mounted with its axis vertical on a table to be slid along a lathe bed. Through a hole in the table frame the bar to be threaded was passed. A tool-holder was secured to the top of the disk, through which a concave chisel edge was projected downwards to come in contact with the bar to be threaded, being set by the tangent screw to the inclination of rake which corresponded with the pitch of the screw to be cut. A chasing tool for the same pitch was carried in a slide rest with screw adjustment, and

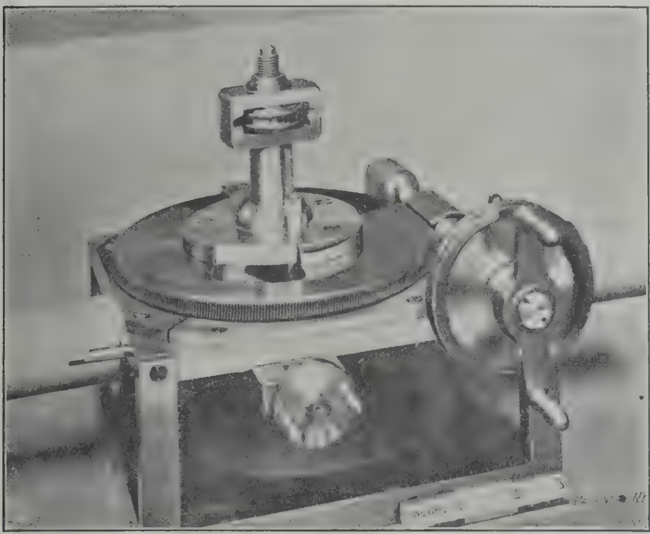

Fig. 15. Maudslay's Machine for Originating Screws (About 1800)

entered a hole at the side. On the bar being rotated, the chisel edge compelled the device to travel longitudinally, while the chaser following, cut the thread. The bar was of soft metal or of hard wood, and from this bar copies were made in steel. In the screw generating machine the essential was the setting of the generating instrument to the precise angle of a given screw. Everything depended on the accuracy of this setting. Maudslay produced a guide screw in the generating machine which he used afterwards in the screw-cutting lathe. In the latter he produced a screw 5 feet in length by 2 inches diameter with fifty threads to the inch. Its nut was 12 inches long with 600 threads.

The screwing machines for threading and tapping were made between 60 and 70 years ago in nearly the same designs as many are at present. They were of horizontal type with

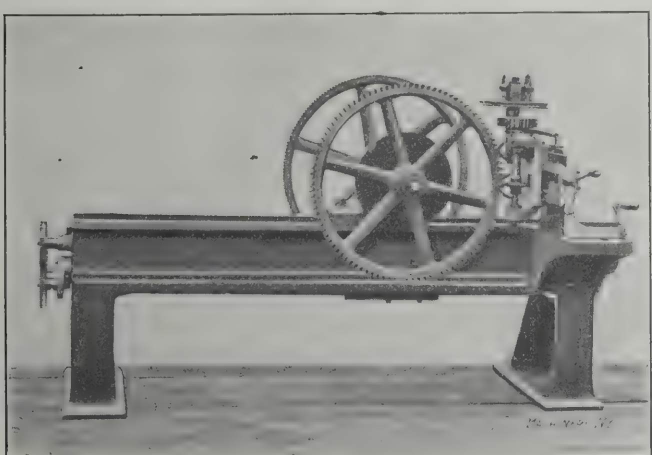

Fig. 16. Gear-cutting Machine, Joseph Whitworth & Co. (1868)

either one or two spindles revolving the bolts, and a cross bar carrying the dies. After cutting, the reversal of the spindles ran the nuts off. A dark fish oil was used for lubrication. Apart from the slowness of their operation they gave practically as good results as those of to-day.

There was a nut tapping machine in the Maudslay shops, and also a bolt screwing machine with a long lead screw in front of the bed having a buttress thread of coarse pitch, and a swing plate with change gears. The clasp nut was a half nut occupying the front portion of the screw, with which it was held in contact by a massive pear weight, much as the pawls of some hand cranes are now. On lifting this at the completion of a traverse, a suspended weight at the right-hand end of the bed pulled the carriage back ready for another cut.

Gear Cutters and Milling Machines

Maudslay made form bevel gear cutters of a peculiar kind, supported on flat topped lathe type of beds. The headstock, comprising two bearings and a mandrel, carried a dividing wheel at the rear end of the mandrel, and the wheel blank at the front end. On a small shaper arm standing out from the bed the tool holder was reciprocated by a crank motion. The inner end of the bar was pivoted on a point in the axis of the mandrel, while the other was fitted with a finger which was retained in contact with the form; a hollow templet larger than the tooth shape held in an adjustable bracket.

Fig. 16 illustrates a Whitworth spur gear cutting machine of date 1868, having a capacity up to 4 feet 6 inches. It is of a design that was very popular a few years ago. The dividing wheel is seen on the farther side of the bed. Its large diameter is noticeable. The cutter spindle is cord-driven, power being gained through spur gears. The change gears for pitching are seen at the left-hand end of the long bed, and the index handle for operating it at the right-hand end. The cutter slide has a self-acting feed across the tooth faces, and is arranged to swivel in the horizontal and vertical planes for dealing with bevel and worm gears.

A small cutter forming machine by Whitworth & Co., date 1868, is seen in Fig. 17. It is based on the principle of some gear cutters of the period, using a dividing head with circles of holes and an index peg. Its cutter spindle was cord-driven, the cord running over small guide pulleys, and the cutter

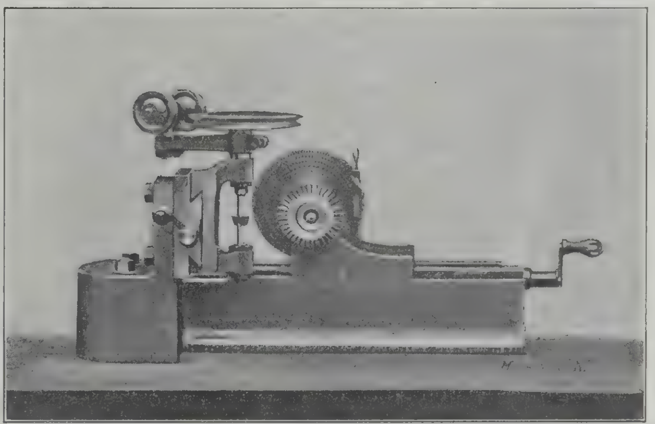

Fig. 17. Cutter Forming Machine, Joseph Whitworth & Co. (1868)

slide was traversed by hand. The cutter was mounted on the spindle of the dividing head, and the slide which carries the latter was adjustable along the bed by hand to suit cutters of different diameters. The cutter head is arranged to swivel in horizontal and vertical planes to suit angular and other cutters. Formed cutters are produced by hand profiling by means of the two handles shown.

The employment of rotary cutters in place of single-edged tools was an epoch the full development of which has been reserved for quite recent years. The first note of this was sounded more than a century ago when one Vaucasson, a Frenchman, invented the milling cutter. It was a very imperfect milling tool, with the teeth of much finer pitch than modern practice allows. The cutter was inefficient in its first form, and nothing but the lathe was available for its operation, and thus the single tools continued to hold their own until the demands made by governments for interchangeability in the parts of small arms brought the opportunity to the circular cutter. Eli Whitney was the man who first recognized, or at least actually developed, its capabilities, and he invented and developed the earlier type of machine for its operation.

There was a nut milling machine in Maudslay's shop in 1829, having been devised as an attachment to the lathe by Nasmyth, who had recently commenced working there. Maudslay wanted a model of a 200 H. P. marine engine made, and entrusted the work to Nasmyth. There were about 300 cast steel nuts to be made, and Nasmyth rigged up a dividing

plate and nut spindle on the slide rest of a lathe and shaped the faces with a milling cutter or "circular file" held in the headstock spindle. Subsequently a special machine was built for nut cutting for use in the factory, and when Nasmyth went into business for himself he built numbers of them for engineers.

Nuts were commonly shaped with a milling cutter in England more than 60 years ago. There was a machine by Archibald Milne of Glasgow in which an end mill shaped the faces. The nuts were mounted on a vertical mandrel projecting from a circular table, having 6 equidistant notches, locked with a spring catch and lever. A self-acting feed was provided for moving the nut up to the cutter. It was cord-driven from four-speed pulleys through a worm and wheel, pinion and rack on the under side of the table. The cutter spindle was driven slowly through spur gears from fast and loose belt pulleys.

A nut milling machine of 1866 by Whitworth is seen in Fig. 18. The nut mandrel was rotated by a worm gear and locked with a pin passing through holes in a division plate. The mandrel head was traversed along the bed past the cutter by a screw, and knocked out by a self-acting clutch arrangement. The cutter drive was by belt and worm gear enclosed. The nut mandrel is firmly held by a self-centering

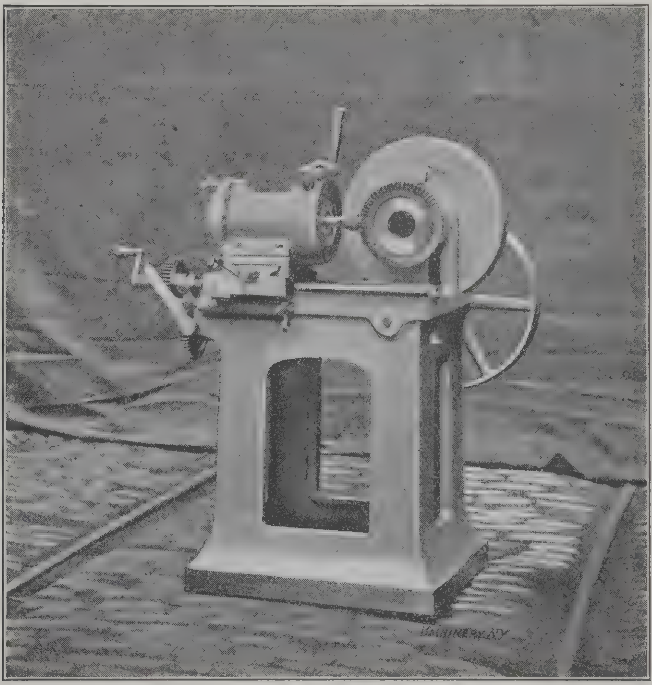

Fig. 18. Nut Milling Machine, Joseph Whitworth & Co. (1866)

three-jaw chuck, actuated by the worm and worm wheel. The chuck is formed with a sleeve which takes its bearing in the head and has keyed to it at the left-hand end a division plate. The chuck and nut mandrel are rotated by hand, and the position defined by a taper pin passing through holes in the division plate. The mandrel head is fed automatically along the bed past the cutter and tripped at any desired point. The cutter drive is by belt and spur gear enclosed.

Mr. Bodmer of Manchester had made a milling machine about 1824. But that was not strictly the first, which was one the late Mr. Parkhurst had seen, and was informed that it was at work in 1818 at a gun factory at Mill Hollow, Middletown, Conn. It was a hand machine. The cutter was driven by a belted headstock, with a three-stepped wooden cone removed from a lathe. The work was traversed under the cutter by a hand crank turning a pinion which slid a rack under the work table. If a second cut was required it was packed up. The idea was there but few improvements occurred until about 1850 when the Howe machine was introduced resembling in several respects the Lincoln miller designed by Mr. Pratt in 1854, in which for the first time a screw feed was substituted for that of the rack. The period of the American Civil War was prolific in milling machines used in the manufacture of small arms. All were of horizontal spindle design, and all were modeled essentially on the Lincoln type. The first universal machine was built about 1865 after the design of Joseph R. Brown, one of the founders of Brown & Sharpe Mfg. Co. The machine, Fig. 19, is still in existence in the works. Essentially it comprises the features of present-day machines, but the latter embody many features which add to their convenience and fulfill the requirements now demanded of a machine.

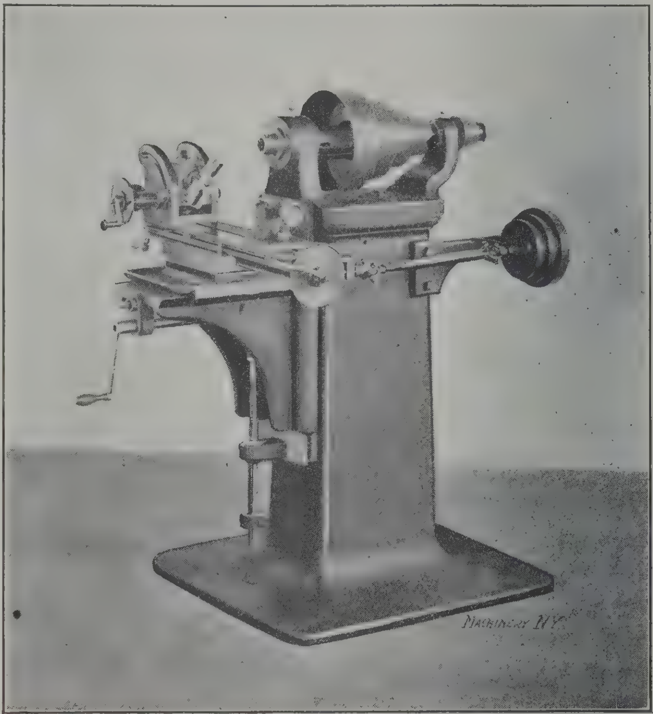

Fig. 19. First Universal Milling Machine. Built about 1865 by Joseph R. Brown, of Brown & Sharpe Mfg. Co.

Fig. 20 illustrates a very massive milling machine with inserted tooth cutters by Whitworth & Co. in 1867. It was designed for tooling the flat faces of marine cylinders and work of similar character. It was driven by a steam engine through worm gear. The work was attached to the table in front, which slides on a bed in front of the main upright, and is provided with cross adjustment by hand. The automatic feed of the table along the bed is operated from the

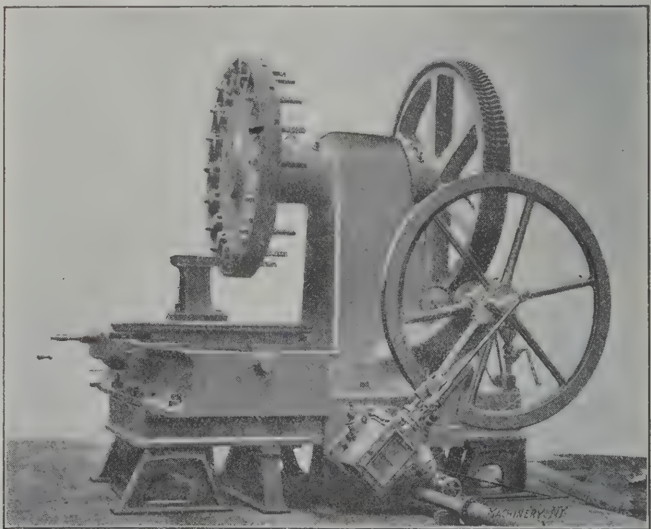

Fig. 20. Very Large Type of Milling Machine, driven by Steam Engine. Joseph Whitworth & Co. (About 1867)

worm shaft through change gears, and worm wheel on the screw, disconnected by hand-operated clutch at the left-hand end of the bed. The cutters are ordinary tools, each fixed by a clamp plate and two bolts, and may be placed with their cutting edges either on the edge or on the face of the disk as desired.

Nasmyth was the first to build the independent machine tool driven by its own small engine, abandoning the shafting, pulleys, belting, and laying down steam pipes instead. This arrangement has met with great favor in boiler making and plating shops where the machines are mostly heavy and scattered. Such machines are still made and used, though the electric motor drive is rapidly displacing them.

THE MAKING OF TOOL STEEL

ERIK OBERG*

Few mechanical processes have, during the general progress of engineering, undergone so little change as the methods and processes employed in the making of tool steel. With the exception of a more direct method for introducing the carbon into the steel, it may be said that, in general, the same methods are still used as were employed centuries ago. Improved methods for heating the furnaces and for handling and working the steel at various stages of the manufacture have, of course, been introduced but there has been no new principle applied in the actual production of the steel.

Before describing in detail the various processes and operations involved in the making of tool steel, the general procedure may be briefly reviewed as follows: Tool steel is made by using low phosphorus and sulphur wrought iron and adding carbon to it. Two methods have been in use, the older one being the so-called cementation process, in which the wrought-iron bars are packed in air-tight retorts with powdered charcoal placed between the bars. When the retorts are thus filled, they are put into a furnace, called the cementation furnace, where they are heated to a red heat and permitted to remain at that temperature for several days. During this time the iron will absorb carbon from the charcoal up to about 1½ per cent of its own weight. The process, in fact, is similar to the ordinary case-hardening process for giving parts made of low-carbon machine steel a hard high-carbon surface. The carbonized bars, called "blister" steel, are then cut up into small pieces and are re-melted in a crucible, and from that poured into molds. The billets thus formed are afterwards hammered or rolled into the desired shapes.

The newer method, largely employed at the present time, consists of putting small pieces of wrought iron directly into a crucible together with the proper amount of powdered charcoal. This charge is then melted and permitted to remain in the molten state for some time before being poured into molds. While in the molten state the iron will absorb the carbon much quicker than when only red hot, as in the cementation process. When the carbon is added directly in the crucible it is also possible to more accurately determine the carbon content of the final product and for this reason the newer method is far superior to the cementation process, which, however, is still considerably in use in the old steel manufacturing districts in Europe. The newer method is more commonly in use in America, and is the method employed in the steel-making plant of the Heller Brothers Co. of Newark, N. J. It is the object of the present article to briefly describe the making of tool steel as this process is carried on in the works of this firm.

Fig. 1. Tool Steel Furnace and Charging Floor at the Heller Brothers Company's Plant, Newark, N. J.

History of the Heller Brothers Company

The original business of which the present plant of the Heller Brothers Co. is an outgrowth was established in 1836 by Mr. Elias Heller, the grandfather of the present officers in charge of the company's business. Mr. Heller at that time engaged in the making of files and horse rasps in a small shop in what is now the central part of Newark, N. J. Up to that time English files had been used exclusively in the United States and Mr. Heller was one of the first, if not the very first man, to make files in this country. The business gradually grew until the first buildings of the present factory were erected in 1873 at Forest Hill, a suburb of Newark, ten miles out of New York City on the Erie Railroad.

It was found that a relatively low-carbon steel of a uniform composition, such as is required in the manufacture of horse rasps was impossible to obtain at that time in the United States at a reasonable price, and, for this reason, in 1881, the firm built a small plant for the manufacture of high-grade tool steel primarily for its own use. Since then, however, this department of the plant has been considerably increased so that at the present time the firm manufactures a considerable quantity of steel for the market, specializing particularly in high-grade brands of carbon tool steel and high-speed alloy steels. The plant now includes a melting furnace having a capacity of thirty crucibles at a time, a number of steam hammers and a small rolling mill, besides the required heating and annealing furnaces. In 1899 the firm was incorporated under the name of Heller Brothers Company.

* Associate Editor of MACHINERY.

Material Used for Making Tool Steel

The raw material used by the Heller Brothers Co. for the making of tool steel is Swedish (Dannemora) wrought iron having a carbon content of from 0.10 to 0.20 per cent. This

Fig. 2. The Charge of Swedish Iron, Bag of Charcoal, and the Clay Crucible in which the Charge is melted

iron comes in flat bars, ½ by 2 inches, and is cut up into small pieces about one inch wide. The reason why Swedish iron is used in preference to other kinds is that it has proved itself superior in the making of high-grade tool steels. It is possible to obtain American iron having by chemical analysis practically the same composition as the Dannemora iron, and being as free from phosphorus, but nevertheless, when transformed into tool steel, the final product will not be of the same quality as that made from the Swedish iron. Metallurgists are at a loss to explain the reason for this. Steel makers say that the Swedish iron has more "body"; but, of course,

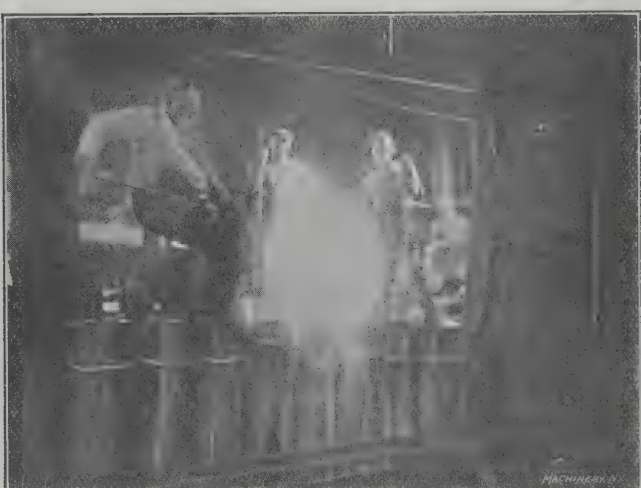

Fig. 3. Pouring the Molten Steel. The Photographic Plate shows the Intense Light and Heat and Fireworks Effect

this in itself does not mean anything except that it produces better results. One cause may be that the Swedish iron ore originally contains less impurities, and that for this reason wrought iron of a given quality can be produced without having passed through, in the same degree, the processes necessary for removing the impurities from the iron ore. These processes possibly change somewhat the crystalline structure of the iron, although its chemical composition remains exactly the same. This is mere theory, however, and should not be accepted as the demonstrated cause of the superiority of the Swedish wrought iron for the making of tool steel.

The Melting Furnace

The furnace in which the crucibles containing the metal are heated, which, as already mentioned, has a capacity of thirty crucibles at a time, is gas heated, the gas being obtained from a gas producer in the company's plant. The furnace is of the Siemens type, the gas entering it alternately from either side through checker plates. The action of the furnace is as follows: When the gas enters on one side, the exhaust gases pass out through the checker plates on the other side; these exhaust gases, being of a very high temperature, heat the checker plates rapidly to a red heat; at this time the entering gas is automatically shut off, and gas is admitted from the opposite side. This gas, then, passing through the heated checker plates, is thoroughly preheated, and when combustion takes place a much higher degree of total heat is obtained. The combustion gases from this side now heat the checker plates on the other side, and the process of pre-heating the gas as it enters alternately from the two sides of the furnace is thus automatically taken care of.

The charging floor, or the floor on which the men work who insert the crucibles in and remove them from the furnace, is level with the top of the furnace and iron-braced fire-brick covers, as shown in Fig. 1, are provided, which are kept over the openings of the furnace at all times except when a crucible is put in place or removed. The furnace, of course, is built up of fire brick, and is covered on top with steel plates. It is kept running continuously day and night, as it would

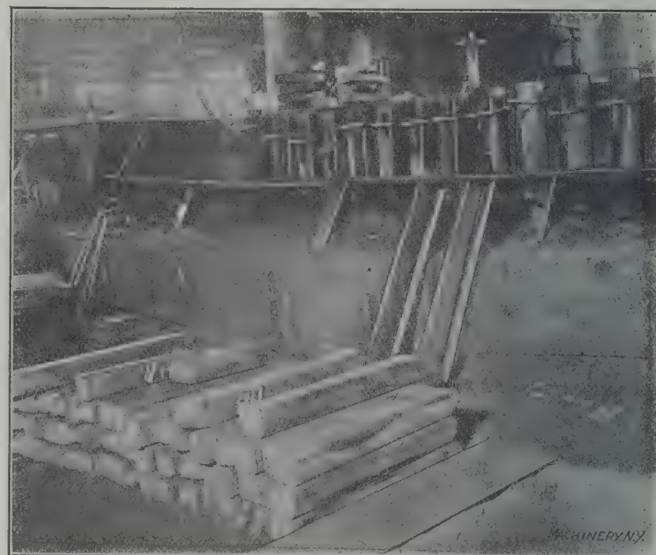

Fig. 4. A Row of Molds ready for the Metal to be poured, an Open Mold, and a Pile of Ingots

crack and be destroyed by the severe internal stresses due to sudden cooling if the fire were permitted to go out. The life of the furnace is from six months to a year, after which time it must be rebuilt.

Crucibles

One of the crucibles used for the melting of the iron is shown in Fig. 2. The height of the crucible is about 20 inches and it is one foot in diameter at the central part.

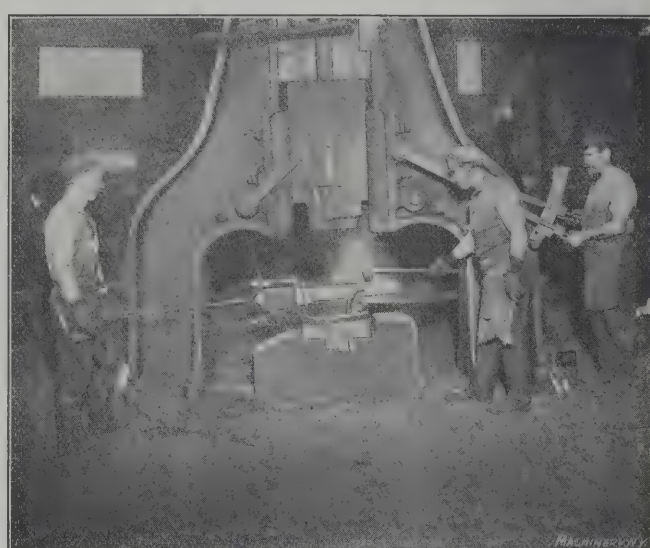

Fig. 5. First Stage in Hammering the Ingot to Size under a 2500-pound Bement Hammer

When placed in the furnace it is provided with a fire-clay cover not shown in the illustration. The crucible has a capacity of seventy-five to eighty pounds of iron. It is made from a mixture consisting of several foreign and domestic clays of

proper proportions. The crucibles are manufactured in the plant of the company, and are made in a manner similar to that used for making clay pots. A form is used to give the outside shape, and a revolving former is employed to shape the inside. When the crucible has been thus formed it is permitted to dry at ordinary room temperature, a storage room being provided where the crucibles are lined up on shelves for the purpose of drying. When properly dried, they

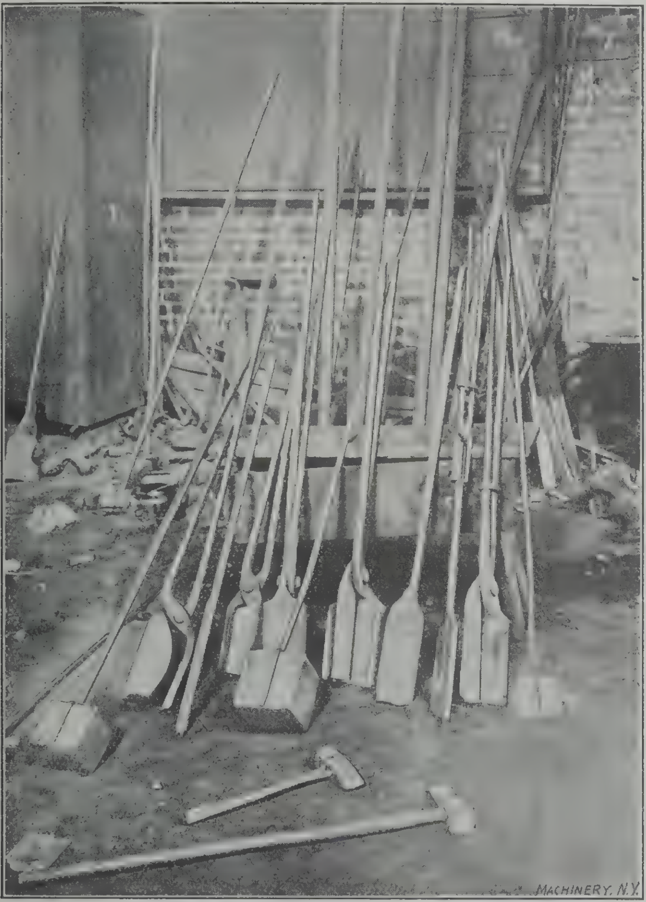

Fig. 6. A Collection of Tools used when handling the Ingots and hammering them to Size

are put into an annealing furnace where they are slowly heated to a high temperature. They must then be taken directly from the annealing furnace while hot, charged with the iron and charcoal, and put into the melting furnace. After this the clay crucible is not permitted to cool off until its usefulness is past. The heat of the crucible and the charge while in the furnace is from 2,500 to 2,800 degrees F.

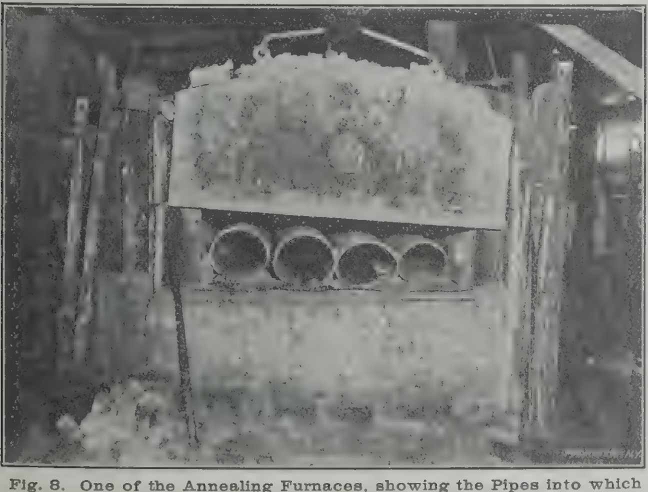

Fig. 8. One of the Annealing Furnaces, showing the Pipes into which the Tool-steel Bars are placed while being heated for annealing

Comparison between Clay and Graphite Crucibles

The use of clay crucibles in preference to crucibles of graphite is important in the making of high-grade tool steel, and is in accordance with the practice employed by the best English steel makers at Sheffield, where the clay crucible has been used for this purpose for centuries past. When the clay crucible is used, there is absolutely no possibility of any extraneous matter mixing with the charge, and the carbon content can be very closely predetermined. When a graphite crucible is used, small particles of graphite will flake off from the inside of the crucible and these particles will mix with the charge. They will, however, not enter into chemical composition with the steel, but will merely mix with it mechanically, so that, in the steel, there will be small particles of graphite imbedded, thus producing small holes and flaws in

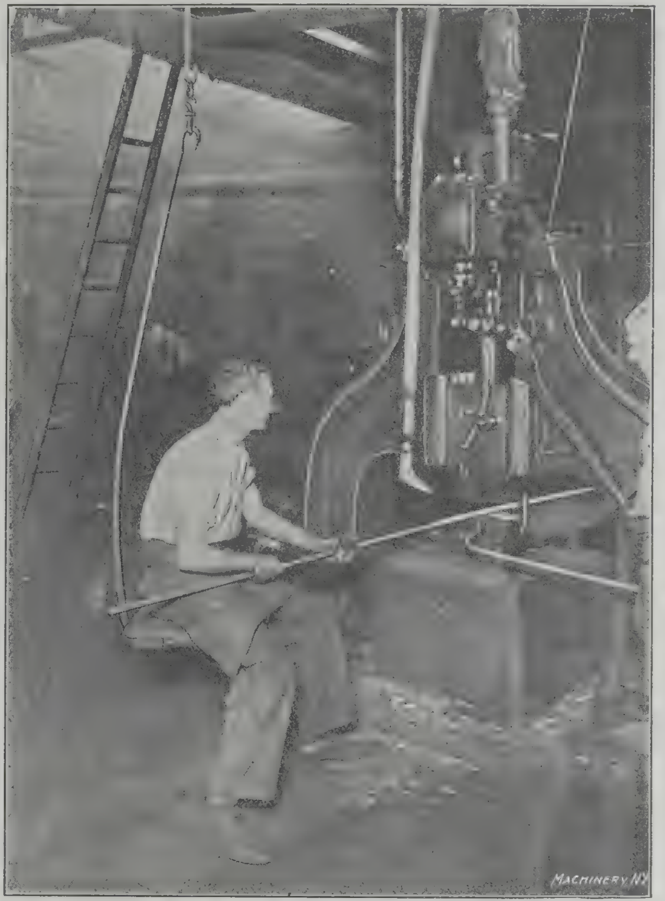

Fig. 7. Hammering a Round Bar to size under a Small Bement Hammer

the finished material. The graphite crucible, however, will last longer, and is therefore cheaper to use, but when a high-grade tool steel is to be produced the clay crucible is the only one which will give entirely satisfactory results.

Melting and Pouring the Steel

The work of charging or filling the crucibles and pouring the molten metal into the molds is carried out on the charg-

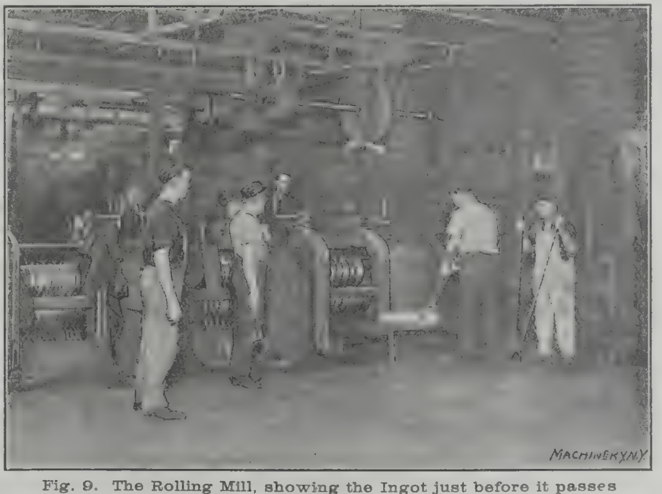

Fig. 9. The Rolling Mill, showing the Ingot just before it passes between the First Set of Rolls

ing floor, shown in Fig. 1. The crucibles are charged with about seventy-five pounds of wrought iron cut up into pieces, as has already been mentioned, a pile of wrought iron ready for the crucible being shown in Fig. 2. About half of the iron is first put into the crucible, then a bag containing the powdered hardwood charcoal, shown on the top of the pile of iron pieces in Fig. 2, is put in, and finally the remainder of

the iron charge is placed on top of this. When high-speed steel is made, other ingredients, such as chromium, tungsten, molybdenum, etc., are placed in the crucible together with the charcoal and iron.

The carbon content in the tool steel is determined by the amount of charcoal in the charge; some carbon, of course, is contained in the wrought iron, so that it is not possible to calculate directly the proportions of charcoal necessary for a certain weight of iron to produce a given percentage. Some of the charcoal is also lost in the slag. The common method of determining the amount of charcoal required, however, is to consider that each ounce of charcoal will give about 0.07 per cent carbon to the steel, or, as the steel maker would express it, one ounce charcoal gives seven "points" carbon. This proportion is approximately correct for ordinary carbon contents, but when steel of a high carbon content is required it is necessary to add charcoal in a greater proportion, partly on account of the fact that the original amount of carbon in the wrought iron is then of relatively less importance, and partly because more of the carbon is lost or wasted. The charge for high-speed steel of standard quality is proportioned so as to give 5 to 6 per cent chromium, 19 to 20 per cent tungsten, and 0.55 to 0.75 per cent carbon.

The crucibles are placed into and lifted up out of the furnace by means of large tongs, the men doing the work standing partly over the furnace while removing the crucible. In Fig. 1 a crucible had just been removed from the furnace from where it was immediately moved across the floor to the molds, which stand vertically, and into which the molten metal is poured to form the ingot. Before pouring, however, but after the crucible has been removed from the furnace, the slag collecting on the surface of the metal is first removed by a long iron bar, and then a small amount of manganese is put into the crucible. This prevents the oxidizing of the metal while being poured, and tends to insure freedom from blow holes or flaws in the ingots. A number of molds ready to have the metal poured into them are shown in Fig. 4, the photograph being taken from the level of the floor of the shop, which is several feet below the level of the charging floor. One of the molds which are made in halves, is shown opened up in this illustration. The molds are made of cast iron and the standard inside dimensions of the molds, and, of course, also the dimensions of the ingots, are four inches square, by about three feet long, the ingots containing about 150 pounds of iron, or the contents of two crucibles with a capacity of seventy-five pounds each. In Fig. 1, one crucible has just been poured into the mold and is now being recharged, while the other crucible stands on the side of the mold ready to be poured. Fig. 3 is a photograph taken at the moment of pouring the molten metal into the mold. The intense heat and the fire-works effect produced is well exhibited in the illustration.

As soon as the metal has been poured, the crucible, which is not permitted to cool off on account of the fact that in such a case it would be destroyed by cracking, is put back into the furnace to be heated up again before recharging. In some cases, when it has not cooled off too much during the pouring, it will be immediately re-charged without re-heating. When re-heated, however, it is removed from the furnace after a few minutes, and the charge put into it as already described. It is then immediately put back into the furnace where it is permitted to remain from four to six hours when it is again removed, and the metal poured, and the same process repeated. As the furnace is in operation day and night, about five heats are obtained in the course of twenty-four hours. A crucible will only last for about four to six heats.

In order to prevent the steel from sticking to the molds, these latter are "smoked" by burning rosin underneath them which leaves a thick black coat of smoke or soot on the face of the mold. The ingots are permitted to cool off in the molds and are then removed and stored in piles on the floor, as shown in Fig. 4.

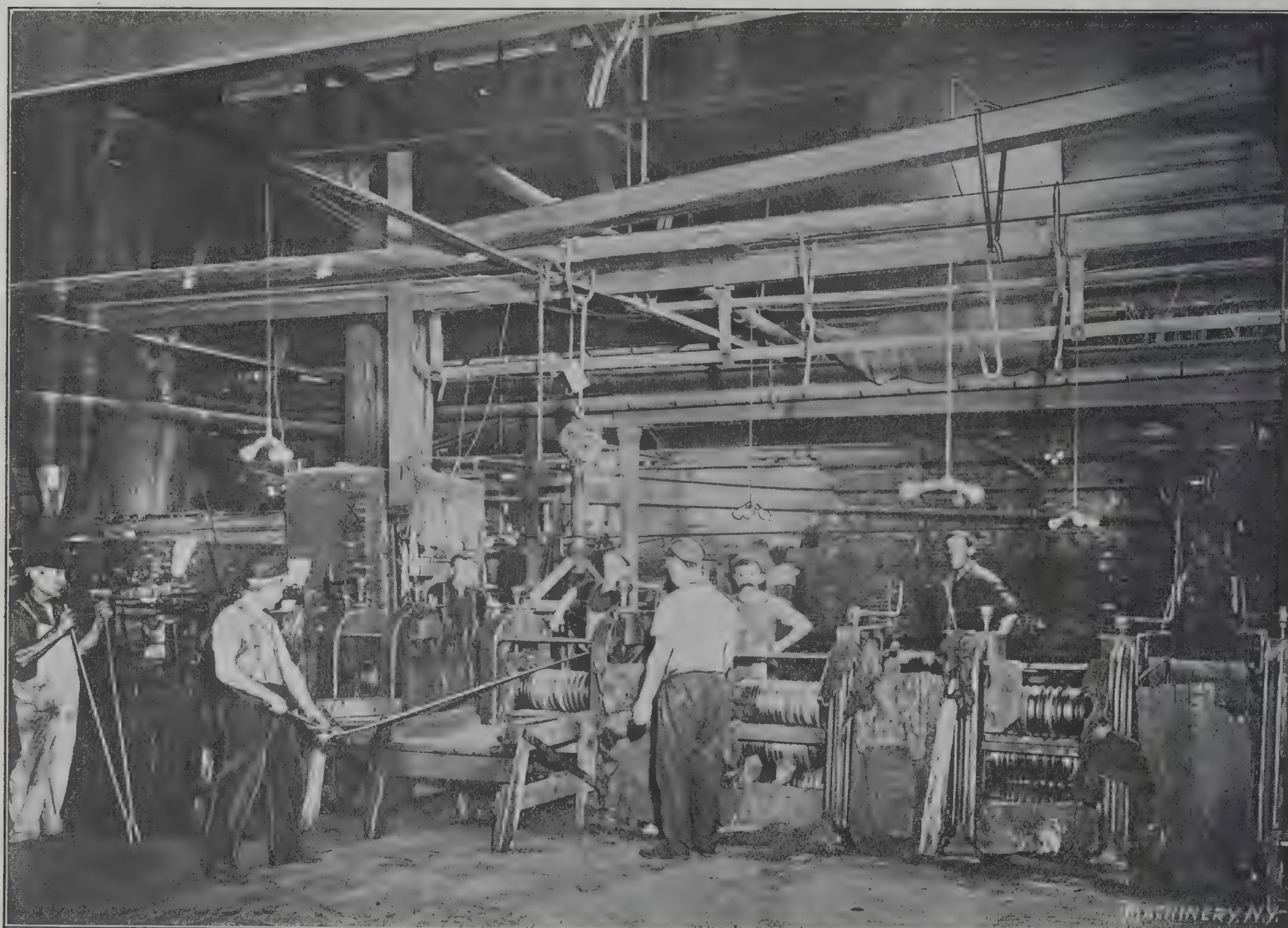

Fig. 10. The Rolling Mill, showing the Ingot after it has been rolled down into a Long Bar of Small Diameter

The Welding Process

The next operation performed is the heating of the ingots in a heating furnace to a welding or white heat, after which

they are put through what is termed the welding process. This consists in placing the white hot ingot under the steam hammer and lightly tapping it with gentle blows on the surface, so as to close up or weld all minute cracks or flaws that may be present on the outside of the ingot. This insures a homogeneous structure and freedom from flaws and cracks in the finished material.

Hammering to Size

After having been welded, the ingot is either again permitted to cool down and it is then re-heated to a red heat, or it may be immediately taken and placed under the steam hammer and hammered down to the required size. In Fig. 5 an ingot is shown where the hammering to size has just commenced. The hammering adds to the firmness and quality of the steel and insures homogeneity of the material. In order to insure the correct size being obtained, tools similar to those employed by regular blacksmiths are used as stops or gages. A square block provided with a long shank, called a peg, of which a number are shown among the tools in Fig. 6, is placed on the anvil of the hammer and acts as a stop. This block is of the required thickness of the bar. When the steam hammer has hammered down the bar to this size, it will strike this block and is thus prevented from making the bar undersize. Two thin or flat blocks are also shown in Fig. 6, these being used to give the right thickness to the smaller sizes of flat bar stock. After the bar has been thus hammered down to a given size by using the pegs as stops, it is gaged by sheet iron snap gages at various places, in order to ascertain if it has the correct size uniformly along its whole length.

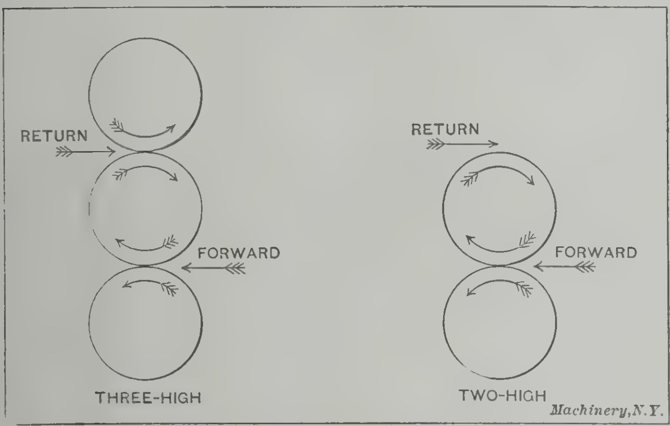

Fig. 11. A Diagrammatical Sketch showing the Difference between the Action of Two- and Three-high Rolling Mills

Round bars are made in a similar manner, swages similar to those used by the ordinary blacksmith being employed to obtain a round and smooth surface. In Fig. 7 is shown a smaller steam hammer under which the bars are hammered down to their exact dimensions, this being in a sense a continuation of the operation of hammering down the ingot, shown in Fig. 5.

When the bars have been thus hammered down to the correct size, it is necessary to anneal them in order that they may be soft enough for working. The bars are therefore placed in an annealing furnace. This furnace contains a number of long large pipes, the ends of some of which are shown in Fig. 8. They are regular cast iron water or gas pipes. The bars are placed in these pipes and the ends of the pipes are carefully sealed with fire clay. After this the front of the furnace is closed by the door or cover shown in the illustration, and the furnace is heated for about twenty-four hours; then the fire is deadened and the bars are permitted to slowly cool down for about two days. When the bars are taken out of the annealing furnace they are ready for shipment.

The Rolling Mill

All the ingots, however, are not hammered into shape; smaller sizes of square and round stock are rolled to the required size. Two illustrations of the rolling mill are given in Figs. 9 and 10. The ingot is first heated to a high heat and is then placed between the first set of rolls illustrated in Fig. 9, where the ingot is shown ready to pass for the first time between the rolls. It is here passed between the rolls from one side to the other, becoming smaller in cross section and of greater length at each successive pass. It is of interest to note how the mechanical operation of rolling keeps the heat in the bar, so that a great number of "passes" can be made without losing any of the original heat; as a matter of fact, the bar shows even a higher degree of heat at successive stages, the work performed on the iron in the rolling process being partly transformed into heat.

In Fig. 10 the ingot is shown rolled down into a long bar of small size. This illustration also shows to the left the heating furnace, and the general arrangement of the rolls and the rolling mill. When the ingots are to be rolled down to very small sizes it is necessary to divide the rolling operation into two stages, owing to the great length of the bar when it has been rolled down to a comparatively small size. In such cases the bar, after having first been rolled down to a certain size, is cut up under shears into shorter pieces of equal length, immediately after coming from the rolls. These pieces are re-heated in the furnace and are again passed between the rolls to produce the smaller sizes.

The rolling mill shown in Figs. 9 and 10 is what is called "three-high," that is, it consists of three rolls over each other, of which the bottom and top rolls run in the same direction, while the middle or center roll runs in a direction opposite to both. From the diagrammatical sketch, Fig. 11, it will be seen that by this arrangement it is possible to pass the bar first through the two lower rolls over to one side and then back again through the two upper rolls to the first side. In this way the bar is reduced in size a certain amount each time it passes back and forth. When rolling mills are provided with one set of two rolls only ("two-high") and are not made reversing, as is the case with the set of rolls shown in use in Fig. 10, it is evident that it is possible to pass the bar between the rolls only in one direction, and the bar must be passed back over the top roll to the front side "idle," as is plainly shown in the engraving. When the bar has been rolled down to the required size it is annealed in the same manner as described for the hammered bars, and is then ready for shipment.

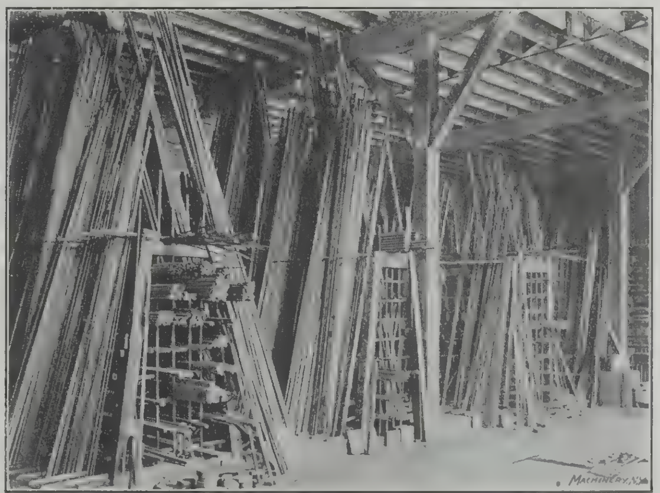

Fig. 12. A Corner of the Stock Room

In Fig. 12 is shown an illustration of a part of the stock-room, showing the finished bars in the racks.

* * *

The freedom from corrosion of tantalum, says the *Scientific American*, has suggested the employment of this metal as a material for writing pens, but tantalum pens have failed to pass a test for durability that is applied in France to steel pens. This test consists in loading the pen with a weight of 180 grammes (6 1/3 ounces) and moving a band of paper beneath and in contact with the pen at the ordinary speed of writing until 10 kilometers (6¼ miles) of paper have passed. The loss in weight of the pen should not exceed 0.7 milligram (0.0108 grain). The tantalum pens were found to lose more than twice this amount, but the loss has been reduced to 0.8 milligram (0.0123 grain) by slightly oxidizing the tantalum.

POWER TESTS OF A STOCKBRIDGE SHAPER

H. P. FAIRFIELD*

The following tests were made on an 18-inch shaper built by the Stockbridge Machine Co., Worcester, Mass., to obtain data relative to the size motor best adapted for driving the machine under normal conditions of roughing cast-iron. No attempt was made to learn what it was possible to accomplish by heavy feeding or abnormal depths of cut, but simply to go somewhat beyond the common shop usage in cuts and feeds. The few data shown in Table IV, for example, were taken merely as a check on those shown in the previous tables, as it was considered improbable that a shaper of this size would ever be used for roughing a cut so deep as one-half inch. I may say, at this point, that each table represents the average results of a series of runs made to conform as closely as possible to uniform conditions, and were made after the machine had been tuned up by careful observation and attention to adjustments, lubrication, etc., and with the cutting tool ground to a gage and kept sharpened to the original gage throughout the runs. A high-speed steel cutting tool was used on account of retaining its keenness for a longer interval of time than a carbon tool would do. The cutting speed selected (25 feet) for runs I to IV, inclusive, was decided on as that which would allow the use of either a carbon or high-speed steel cutting tool, and could be said to fairly represent average shop practice. The material cut was an average grade of cast iron such as is used in ordinary machine tool parts, and the block was cast into such a form as to preclude all springing of the work itself.

TABLE I

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/8	17	0.0147	25	1.20
1/8	17	0.0294	25	1.68
1/8	17	0.0441	25	2.14
1/8	17	0.0588	25	2.68
1/8	17	0.0735	25	3.49
1/8	17	0.0882	25	4.02

TABLE II

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/4	17	0.0147	25	1.73
1/4	17	0.0294	25	2.68
1/4	17	0.0441	25	3.22
1/4	17	0.0588	25	3.90
1/4	17	0.0735	25	4.40

TABLE III

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	17	0.0147	25	2.55
3/8	17	0.0294	25	4.29
3/8	17	0.0441	25	6.00
3/8	17	0.0588	25	7.67

Tables I to IV give the average of repeated runs where all conditions of length of cut, depth of cut, and cutting speed were made as uniform as possible for each series, the feed only being varied. The runs were made cutting the full stroke of the machine, a rather unusual condition; but, as it was desirable to know what, if any, additional power might be necessary, if full stroke was to be used, the tests were run as shown.

The additional runs tabulated in Tables V and VI were made to show the effect in power consumption of a change in cutting speed, also as a means of comparing the Stockbridge two-piece crank mechanisms with the ordinary type of crank-shaper. Table V is the average of a series of runs made with the machine in its normal condition as a two-piece crank-shaper, and Table VI is compiled from the same number of runs, but made with the mechanism blocked in such a manner as to convert the machine into an ordinary crank-shaper of the usual type. In making the tests V and VI, the length of the cut was shortened to 12 inches, which conforms very well to the average length of work likely to be done on a machine of this size.

While the cost of power consumed in the average machine shop is not a large percentage of the manufacturing cost, the up-to-date manager is giving this item consideration when he purchases machinery, and when a machine is shown to consume less power and at the same time is adapted to produce the maximum output, he considers it worth while. A glance at Tables V and VI shows that the two-piece crank is a considerable power saver as compared with the regular type of crank-shaper, and while the saving in an hour's time may not appeal to the casual reader, it most certainly will if he uses his pencil and considers the savings effected in a year's time.

These tables are also quite interesting as showing how speeding up in a shop increases the power consumed. While it is a common enough saying among machine users: "It takes power to do work," some cases that have come under the writer's notice lead him to conclude that not all machine men fully realize its full significance. At a recent exposition of manufacturers, a machine tool firm exhibited a line of machines designed to work the modern high-speed cutting tools to their limit. When asked by the exposition management what power it was likely to use, the company's figures were for less than one-half what it actually used. There was no restriction on the power and the company could have been supplied with ample power by merely asking for it, as it was only a question of the wiring and fusing which the management desired to settle. As it transpired, it was necessary for this firm to shut off all but a single machine, changing from one to the other as the show was on.

TABLE IV

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
1/2	17	0.0147	25	3.20
1/2	17	0.0294	25	5.43

TABLE V

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	12	0.0294	15	2.10
3/8	12	0.0294	17	2.68
3/8	12	0.0294	25	3.22
3/8	12	0.0294	30	4.02

TABLE VI

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horse-power
3/8	12	0.0294	15	3.08
3/8	12	0.0294	17	3.35
3/8	12	0.0294	25	3.62
3/8	12	0.0294	30	4.16

In conclusion, the writer desires to again emphasize the fact that the tests were made primarily to establish the size or power of motor to be used as a driver on the above shaper.

* * *

In the report of the committee on fuel economies, at the American Railway Master Mechanics' Association convention at Atlantic City in June, W. C. Hayes, chairman, made the statement that the investigation of the committee has shown that less than three per cent of all the locomotives on all of the North American continent use anthracite, liquid and other than bituminous fuel. Hence, the problem of locomotive boiler design as regards fuel is mainly concerned with bituminous fuel.

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INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS

THE R. K. LE BLOND MACHINE TOOL CO.

ETHAN VIALL*

Many interesting things are to be seen in the machine tool building shops of Cincinnati; some possibly that are not new, others undoubtedly old but nevertheless of the nature of "shop kinks" to many mechanics who have not been fortunate enough to run across anything like them, and in the line of interesting tools and methods the R. K. LeBlond Machine Tool Co., certainly holds its own.

In Fig. 1 is shown the way nine grooves are milled at once, on the outside of the cylinders used on the LeBlond lathes to cover the quick change gears. These grooves are not very long, so the feeding is done by means of the large hand-wheel shown, which operates a worm and gear set into the head of the fixture.

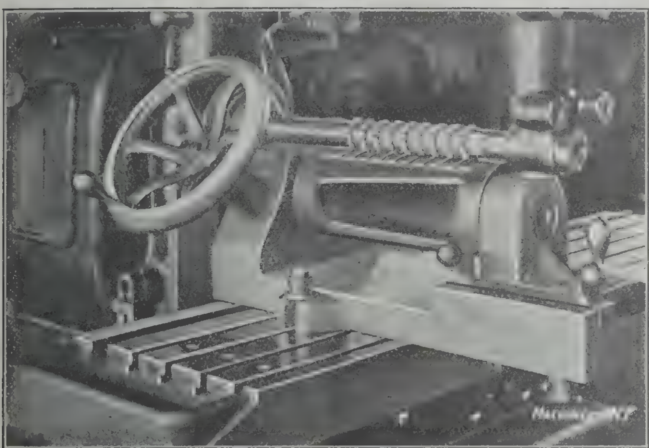

Fig. 1. Milling Nine Grooves simultaneously in a Quick-change Gear Cover

A jig for holding apron half-nuts while milling the dove-tail bevel is shown in Fig. 2. Two of the half-nuts are placed in the jig and the bevel on one side is milled; the jig-head is then indexed half a turn and the job finished. Four different sizes of half-nuts are milled in this jig, which accounts for the four grooves to be seen in the head on each side of the dove-tail.

The slots in the bottom of milling machine vises are milled while the vises are clamped onto a cast-iron block, Fig. 3, the base of which is so made as to be bolted to the milling machine table with the block either parallel or at right angles to the line of feed, so that slots may be milled at right angles to each other, with the same jig.

Short shafts are milled for Woodruff keys, while held in the upright V-vise shown in Fig. 4. This vise is also very

Fig. 2. Fixture for Milling Dove-tail Bevel on Apron Half-nuts

handy for many other jobs where it is necessary to hold round stock.

All sizes of plain cast-iron pulleys are faced and crowned in the special milling machine shown in Fig. 5, and a quicker or neater job could hardly be imagined, as with two mills working on opposite sides, simultaneously, only a half revolution of the pulley is necessary to finish the rim. By referring to the engraving, it will be seen that the pulley arbor and chuck, is driven from underneath by a worm and gear, and the big cutter heads are equipped with both cross and

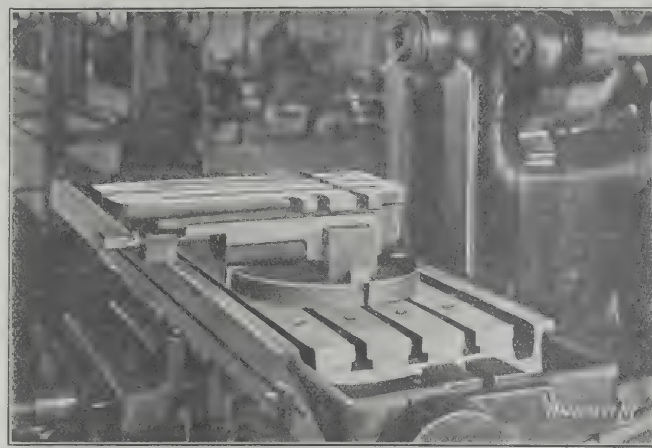

Fig. 3. Fixture for Holding Milling Machine Vises while slotting them

parallel hand feed, making it easy to set the machine for any size pulley within its capacity or to vary the amount of crown wanted on the face. The spindles carrying the milling cutters are back geared and the whole machine is made heavy and powerful in order to do good work.

A neat little jig used for holding the graduated sleeves used on the feed-screws of both lathes and milling machines, while drilling the set-screw hole, is shown in Fig. 6. In order to always have the set-screw hole in the same position relative to the numbers of the graduations, a little pointer for the zero mark on the sleeve is set into the face of the jig. Spacing collars are also used to bring the short sleeves properly under the drill bushing.

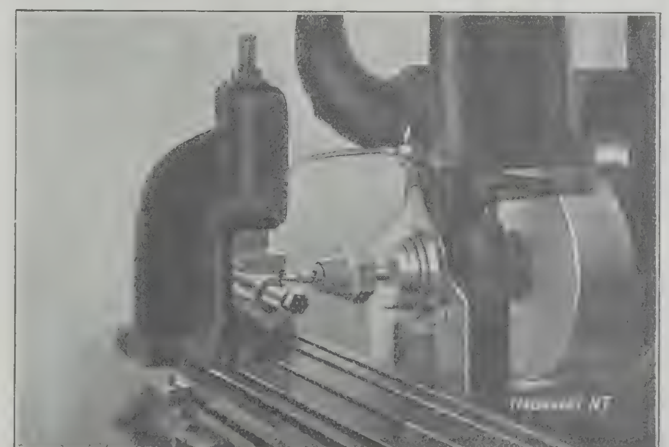

Fig. 4. Upright V-vise for Holding Shafts which are being milled for Woodruff Keys

At *A*, Fig. 7, is a special mandrel on which the large front box nut, for the No. 4 milling machine, is placed and turned after the threads have been cut in it. This mandrel is made to screw directly onto the lathe spindle, the square hole in the center being used for a wrench hold.

After the nut is screwed onto the mandrel, it is locked in place by a slight turn of the handled locking-collar *B*, which has a stop pin *C* set into the back and intended as a guide for setting the locking collar in the same position for each nut, by backing it up against the stop-screw *D*. The width of the nut is gaged by setting the point of the cutting tool against the hardened screw *E*. Another type of mandrel, known in most shops as a friction nose-chuck, is shown at *F* in this engraving. This mandrel screws onto the lathe spindle the same as the one just described, and it is used to hold large bored-out rings or collars, while turning the outside. A ring *G* is shown in place on the mandrel and the way it is locked by the pin *H* rolling and wedging in the beveled notch, is plainly apparent.

Fig. 8 illustrates a little tapping kink which is sometimes very useful when doing special work in the lathe. When

* Associate Editor of MACHINERY.

tapping by this method, the tail-stock spindle is disconnected so as to be free to move out or in; the chuck holding the tap is connected to the lathe carriage by a short piece of rod as shown, the lathe is geared to cut the same thread as that on the tap and with the tap close to the work the feed is thrown in. If in backing out the tap, it is not desirable to use the feed on account of the backlash, the rod is easily backed out of the hole in the chuck, the key in the tail-stock of course keeping the spindle from turning with the chuck and tap, when the lathe spindle motion is reversed. Leading the tap in in this way, is not always possible or desirable, but as was said before, it is sometimes an exceedingly useful kink.

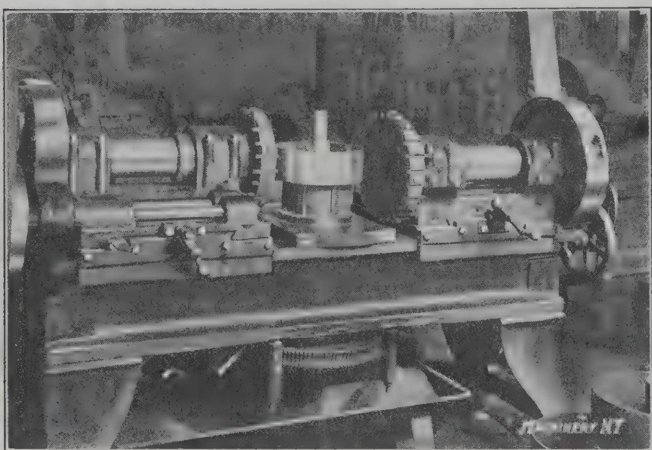

Fig. 5. Pulley Turning and Crowning Machine

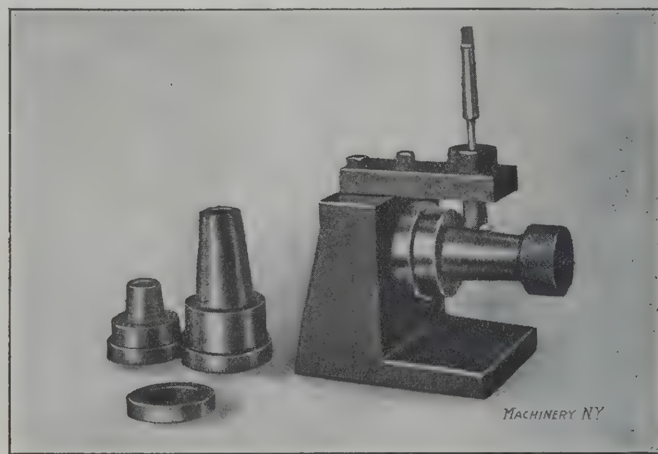

Fig. 6. Drilling Jig for Dial Sleeves

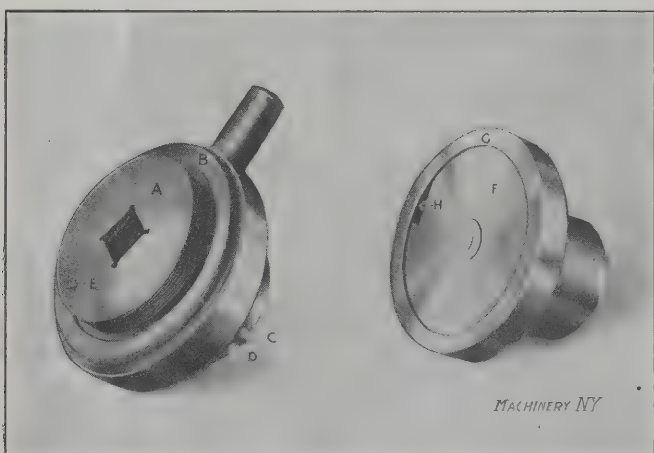

Fig. 7. A Nut Mandrel and Friction Nose Chuck

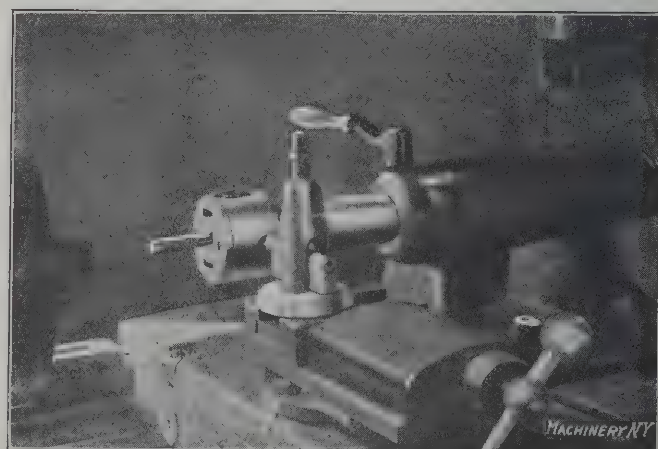

Fig. 8. Lathe arranged for Tapping with the Aid of the Lead-screw

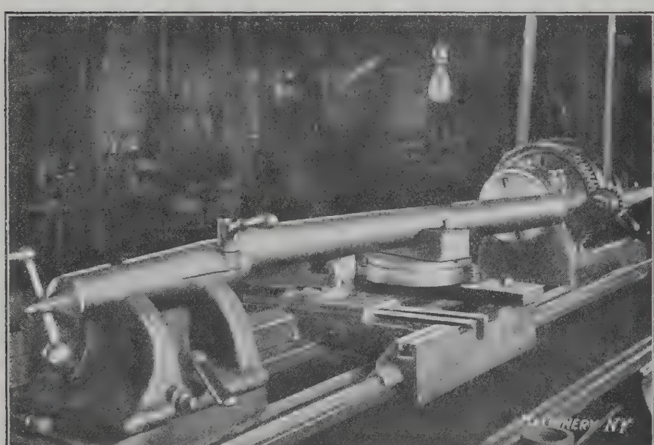

Fig. 9. Turntable for Reversing Heavy Work in the Lathe

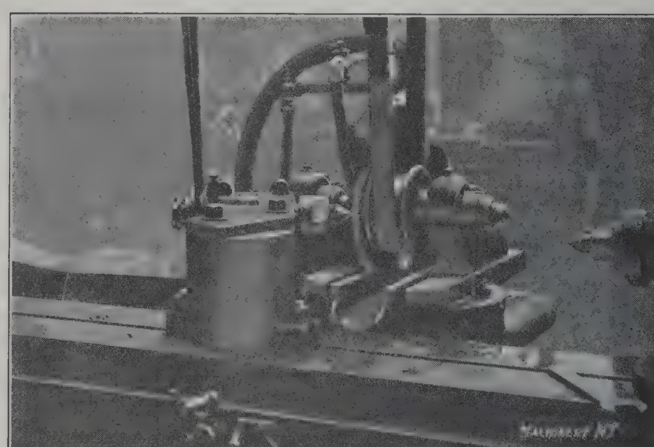

Fig. 10. Grinding the Point of a Foot-stock Center—First Operation

Where heavy work has to be turned end for end in a lathe, a turntable similar to the one shown in Fig. 9 is sometimes used. This kind of turntable is quite common in railroad shops, but it is seldom seen in other shops, even where it could be used to advantage.

The method of grinding the hardened foot-stock centers may be of interest, as it is done differently in some shops. Here the center is held as in Fig. 10, and the point ground; then using a male and female center, as in Fig. 11, the body is finished. Many shops leave a center hole on each end, that on the pointed end being all but cut off; the center is then hardened on this end, which often distorts the end which has been left on for the center hole. Next the piece is placed between centers and the body ground, and finally the center is placed in a split chuck and pointed.

Fig. 12 shows a magnetic chuck which was made by the foreman of the grinding room for special work.

In Figs. 13 and 14 are shown two views of a box jig for holding lathe aprons while machining the holes, and in Fig. 16 is shown the complete set of tools used. By closely examining these engravings, several interesting things may be noted. In the first place, all tools are driven from the drill-press spindle by the universal-jointed shank and socket shown. Then it will be seen that each tool whether drill, cutter or reamer, has its individual bushing which is kept from turning in the permanent jig-bushing, by a pin set in below the shoulder which fits into a notch in the latter; then, too, the long boring-bars B, C, D and E, have keyways running the full length of the pilots for the purpose of engaging keys set into the pilot guide bushings in the jig. These bushings are flanged, and set into another bushing in the jig, in such

a way as to be free to revolve with the boring-bar, instead of having the pilot revolve in it which prevents chips or dirt getting in and scoring the pilot, as usual. The flanges on the inner or guide-bushing keep all dirt from between it and the outer or bearing-bushing, and give long life to both bushings and boring-bars.

in Fig. 15. This jig is made to slide back and forth, in order to bring the work in the proper position under the tool, by means of the hand lever *A*. This lever is made long so as to project through an opening in a sheet iron drum that is placed on the drill press table, around the jig, to keep the soap water that is used from spattering all over the shop.

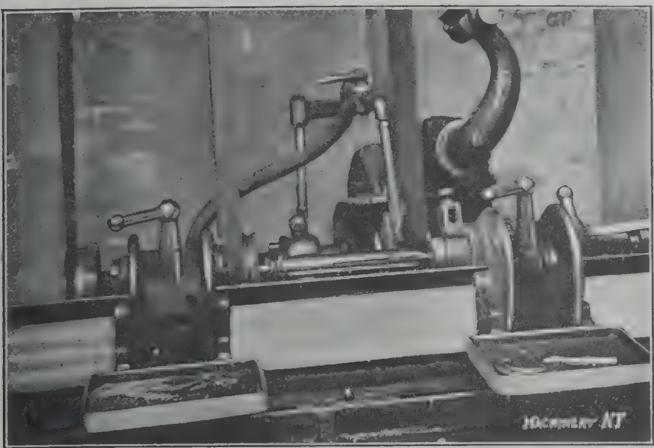

Fig. 11. Grinding the Body of a Foot-stock Center—Second Operation

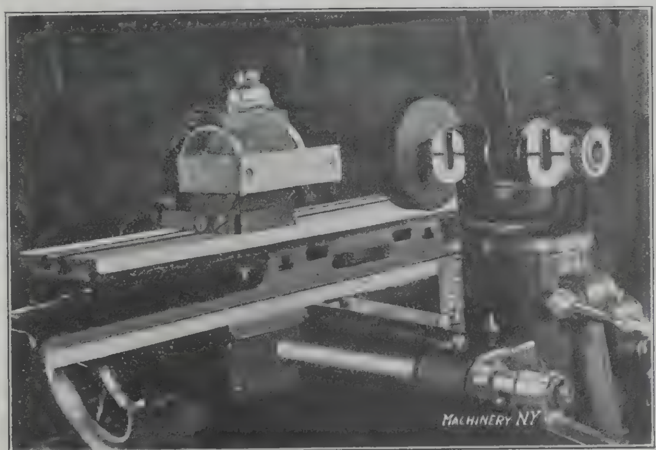

Fig. 12. Home-made Magnetic Chuck

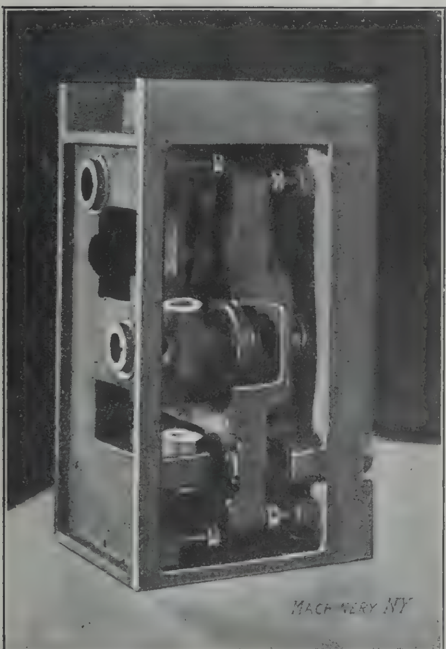

Fig. 13. Box Jig for Machining Lathe Aprons

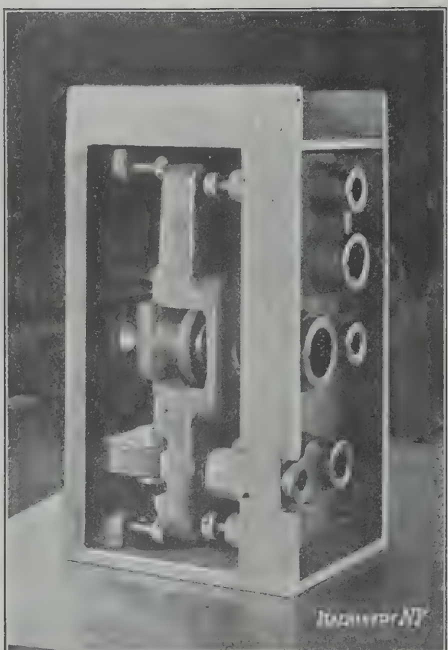

Fig. 14. Another View of the Lathe Apron Box Jig

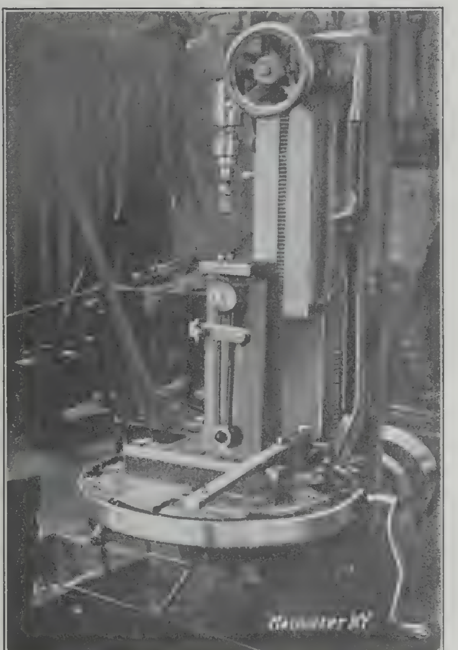

Fig. 15. Jig for Holding Connecting-rods

Fig 16. Tools used for Machining Lathe Aprons

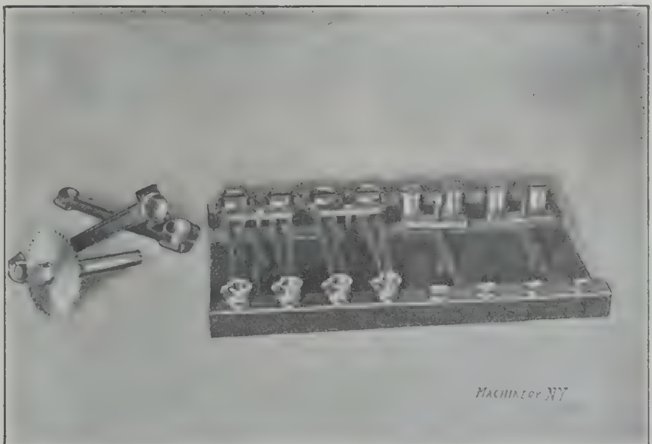

Fig. 17. Fixture in which Connecting-rod Bearings are cut off

During the recent dull season, in order to keep their regular force at work, a contract was taken for the machining of a large number of automobile engine parts, and two of the jigs used for some of the work on connecting-rods are worth describing. These rods and bearing-boxes are cast in one piece, and after the bearings are bored out, the work is put in a jig and the holes in the large end for the oil hole and cap screws, are drilled, counterbored, and tapped as shown

After the holes are finished, the connecting-rods are placed eight at a time in the jig shown in Fig. 17, and the bearing-caps sawed off in a milling machine, using the saw shown.

In Fig. 18 is a front view of a small hand-operated graduating machine, with the part *A* of a compound rest in place, and the tool *B* just finishing a cut, and in Fig. 19 is a rear view, showing the way the machine is geared and operated. The indexing or dividing ratchet-wheel and dog is shown

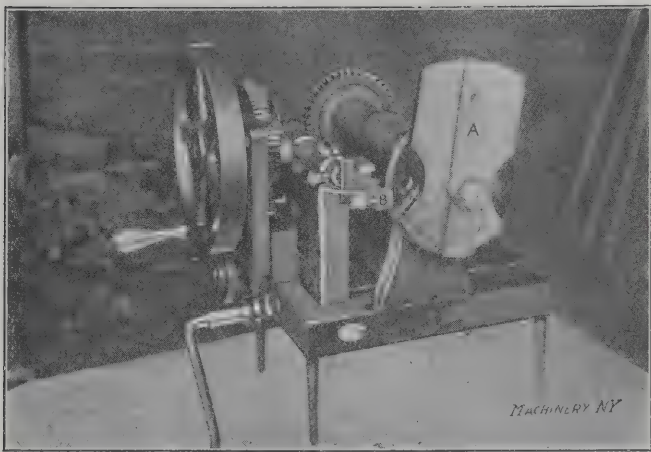

Fig. 18. Graduating Machine—Front View

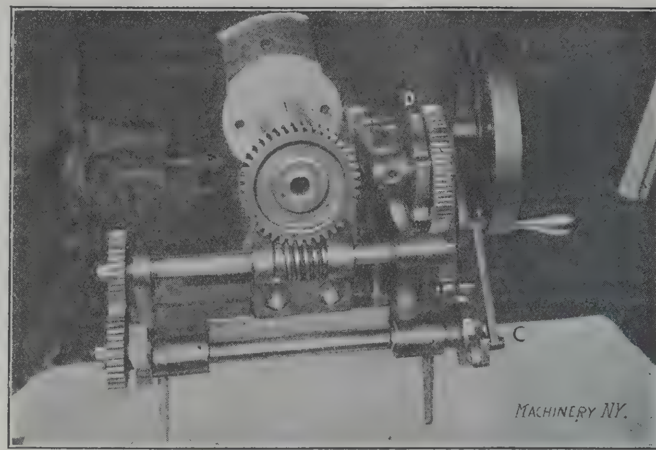

Fig. 19. Graduating Machine—Rear View

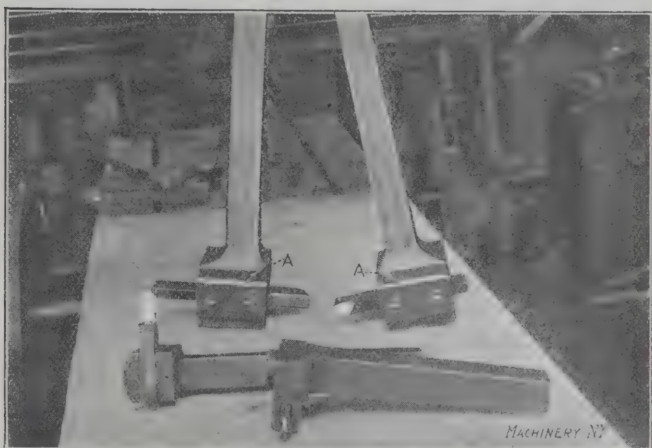

Fig. 20. Clapper-box Planer Tools for Side Facing

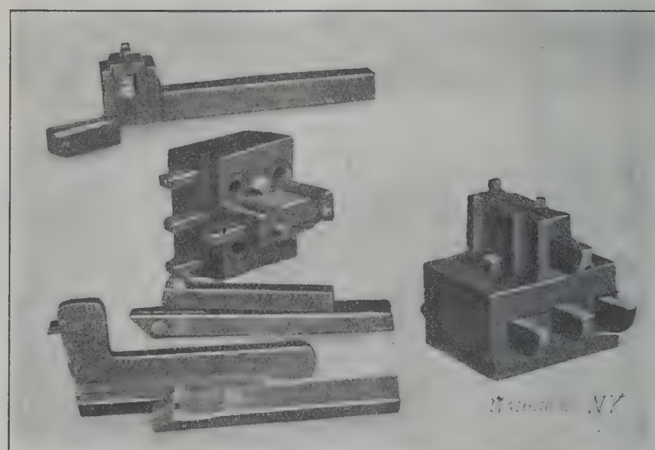

Fig. 21. Miscellaneous Inserted Cutter, Planer Tools

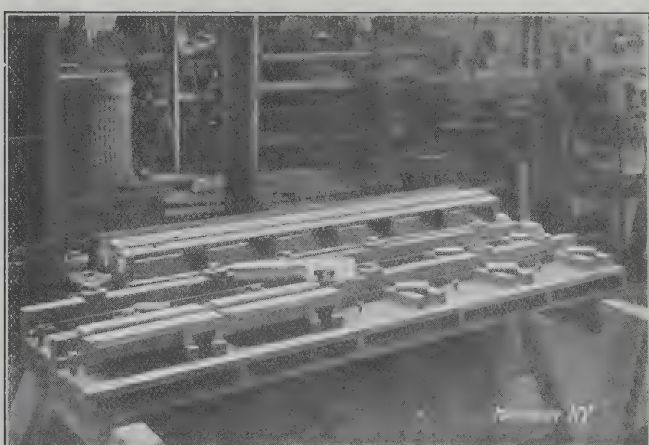

Fig. 22. Fixture for Holding Lathe Carriage Slides while planing them

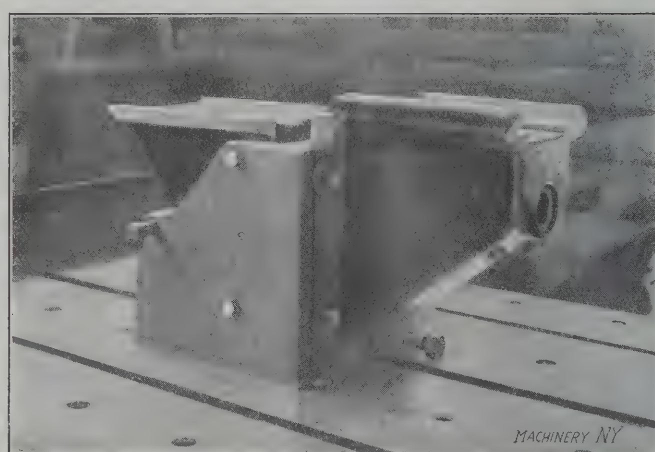

Fig. 23. Combination Fixture for Holding Grinder Knees while planing Male and Female Dove-tail Slides

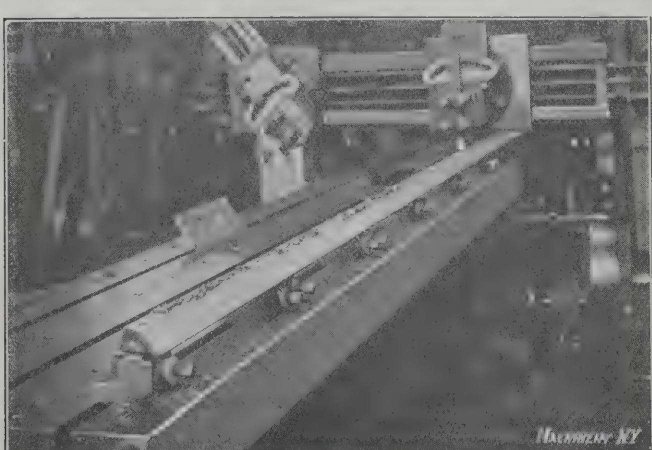

Fig. 24. Simple Form of Fixture for Holding Gibs on the Planer

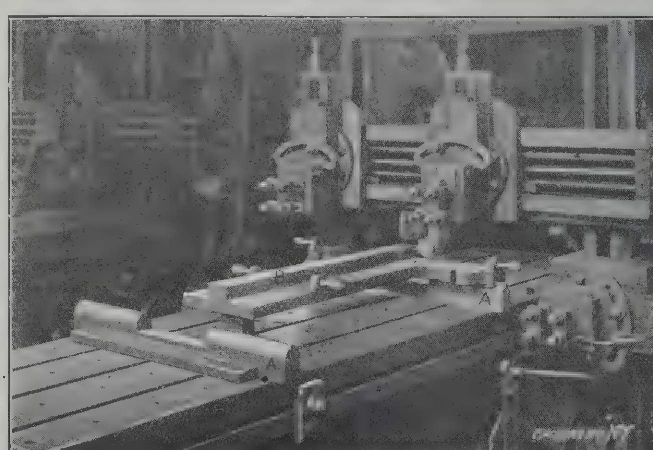

Fig. 25. Gage for Setting False V's for Lathe Carriages

at C, and a cam-wheel with four even and one high rise at D. This cam-wheel gives the tool its four short strokes and one long one, which is the usual motion.

In the planing department, there are a number of "clapper-box" tools such as shown in Fig. 20, used for side cutting on the planer. The two large ones, made right and left, have a little plunger and spring with a crosspiece A, which may be turned lengthwise of the clapper to allow the tool to be drawn back out of the way if necessary, but it is turned crosswise when the tool is in use, in order to draw the clapper and tool back into position at the end of the reverse stroke. Several other forms of tool holders, which need no explanation, are shown in Fig. 21.

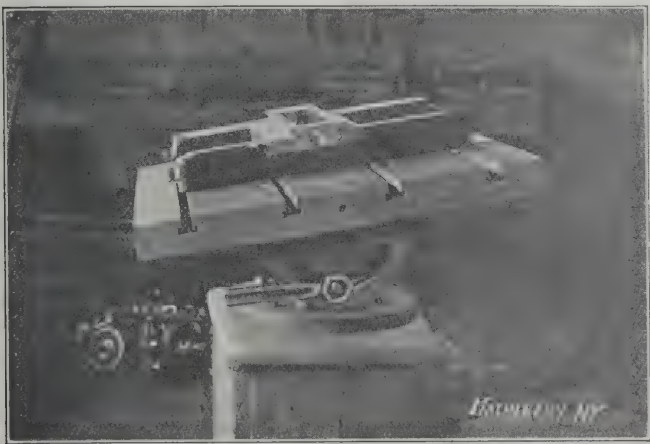

Fig. 26. Adjustable Table for Holding Lathe Carriages or Other Parts while Scraping and Fitting

A jig for holding ten top-slides for lathe compound rests, while planing the bottoms, is shown in Fig. 22, and in Fig. 23, is a combination-jig for holding grinder knees. The illustration shows two in position, but this is only done to show how they are held for the two planing operations, only one, of course, being planed at a time. Fig. 24 shows how gibs are planed, seven at a time, being held by pins inserted in holes drilled in the ends. Lathe carriages are lined up for the planing of the cross-ways, by being laid on the pieces A shown in Fig. 25. In order to get these pieces absolutely at right-angles to the travel of the planer table, the device B is used. This is simply laid on one of the pieces A as shown, and then tested by a dial indicator placed in the tool-holder. When the indicator reads the same for the entire length of B, the cross-piece A is tightened down, and the next one tested. A very handy iron table used to hold carriages or other parts while scraping and fitting is shown in Fig. 26.

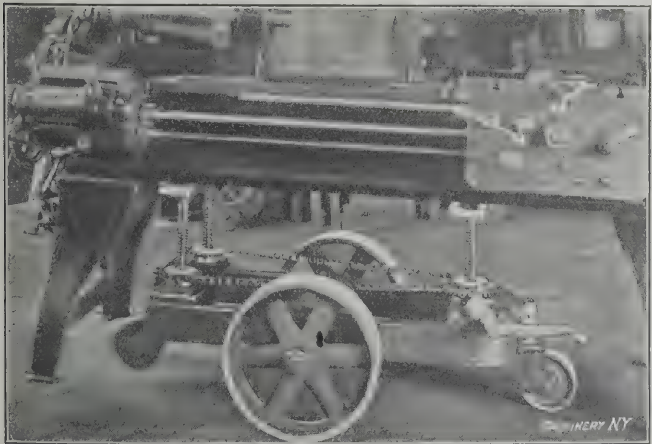

Fig. 27. An Elevating Truck for Raising and Moving Lathes

Every shop foreman knows what a nuisance the starting and stopping of an emery wheel is and how apt a man is to leave it running when he is through with it. The LeBlond shop had the usual trouble and so the arrangement shown in Fig. 28 was put on. As the man steps on platform A, the belt is shifted over and the wheel starts, and as soon as he steps off, the weight B pulls the belt over onto the loose pulley and stops the wheel.

Fig. 27 shows the ingenious truck used to move lathes around, the construction of which can be seen at a glance.

BIG GUN MAKING IN A NUT SHELL

This is how big guns are built at Elswick according to a clipping from *Pearson's Weekly*, a popular British journal, sent to us by a valued contributor. The account is graphic, but, though somewhat lacking in detail, it probably passes muster as the "real thing" with the class of readers to whom such "fluffy" literature appeals:

"Red hot steel ingots are forced into a rough cylindrical shape, either by the pounding of steam-hammers (some of them can give a blow of 700 tons), or by hydraulic presses. The largest of the latter gives a pressure of nearly 6,000 tons.

"Now that the rough forging has been made it has to be tested, and this is a critical part of the process: A few pieces are cut off from the main forging, heated in oil at a temperature of about 1,500 degrees F. and fixed firmly in iron jaws. Hydraulic pressure now tries to tear each lump in two, the strain sometimes rising to 46 tons on each square inch. If all the sample pieces stand the test, the forging is held good enough to make a gun. If not, another forging is made.

"If the test is satisfactory the rough pillar of steel is now 'rough-bored' inside and 'turned' on the outside. Then it is hardened by being dipped into a bath of hot oil; then bored and turned again till smooth; then annealed, or allowed to cool slowly from a high temperature; then it is 'fine bored' and 'fine-turned.' The next process is that of testing the surface. It is tested both chemically and by mirrors.

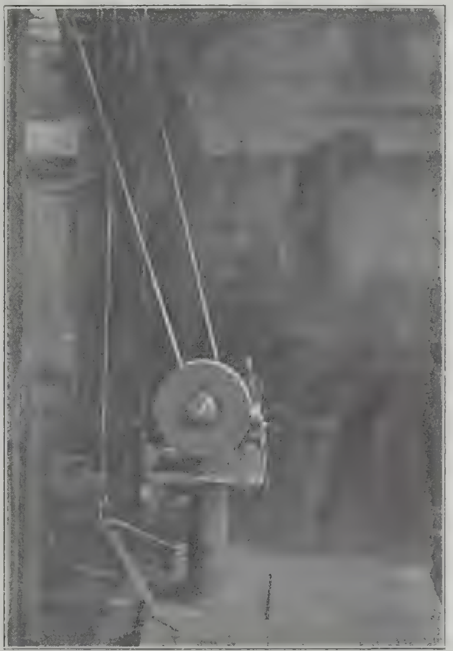

Fig. 28. Automatic Emery Wheel Belt-shifter

"The gun is now well into shape, but it needs strengthening. A deep pit is dug, and the gun set upright in it. Red-hot hoops of steel are dropped on from on top. As they cool they tighten. After each layer of hoops the gun is planed by a lathe to make it smooth for the next layer.

"Now the inside is rifled or grooved like a screw. When the powder chamber has been bored out and the breech-block fitted, the gun is nearly ready for its trials. The Elswick big guns are tested near Silloth, on the flat and lonely shores of the Solway Firth."

* * *

A remarkable high-speed run of regular passenger trains is being made by the Great Western Railway of England, in connection with transporting the passengers of the Cunard liners from Fishguard to London. The total distance from Fishguard to London is 261 miles, a distance which was covered, on August 30, in 268 minutes by the special mail train, and 276 minutes by a passenger train consisting of ten cars, and weighing 274 tons. The first part of the run is a difficult one, owing to heavy grades, including one, over a mile in length, of 1 in 50. The latter part of the run, however, presents more favorable conditions and the run from Carmarthen to London, a distance of 230 miles, was made in 228 minutes, including a stop of four minutes. At one section 75 miles were actually covered in 60 minutes, and 100 miles were covered in 83 minutes 49 seconds, a remarkable performance with so heavy a load behind the tender. The locomotive pulling the train was a four-cylinder, non-compound, six-wheel coupled engine weighing 75½ tons, cylinders 14¼ by 26 inches, working pressure 225 pounds, and with driving wheels 80½ inches in diameter.

AN ELECTRIC SURFACE GAGE

GEO. J. MURDOCK*

Geo. J. Murdock†

The purpose of the electric surface gage is to obtain aural as well as visual evidence of the truth of a plane surface. There are places on many classes of work, such as jigs, where it is difficult to see whether or to what extent the surface is out of truth, with the common surface gage. This is notable where there is an overhanging projection so close to the surface plate that it is impossible to look under. In dark weather it is very trying on the eyes to see whether the fine point of the needle touches the work or to what extent it does not. The electric current will communicate an audible signal when the needle comes in contact with the work, when under the most favorable circumstances such contact cannot be seen with the eye. This surface gage can also be used for many purposes for which the usual type is comparatively useless; for instance in truing up work on the face-plate or in a chuck, concentric with the axis of the lathe spindle, or for ascertaining the truth of a shaft between centers in the lathe or an arbor in the same position. When the pointer makes contact with the work, the electric current will speak to the brain through the ear where the eye cannot see.

Fig. 1 shows a side elevation of this gage. Its general design is similar to that of the gages in common use. The

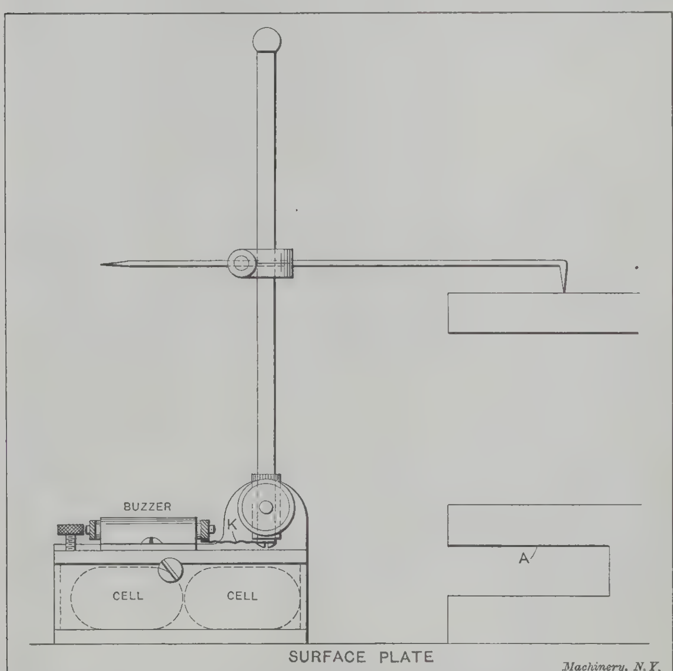

Fig. 1. Surface Gage equipped with Electrical Apparatus for Producing Sound when the Pointer is in Contact

base is cast with a recess in the bottom in which lie on their sides, two small dry cell batteries known as "Ever Ready" No. 650. This cell is 1¼ x ⅝ x 2 inches, and is especially adapted for this work. The ends of the cells are shown in Fig. 1 by dotted lines. On the top of the base is a small buzzer known as a midget, which is noisy enough for the purpose and which occupies but a small space. The positive and negative terminals of the cells are soldered together as shown in Fig. 3. The cells are then inserted in the base so that only the terminal G of the battery comes in contact with the metal of which the base is composed. The other terminal is passed up through a hard rubber bushing H (Fig. 4), and connected by a wire J to one binding post of the buzzer. The other binding post is connected to the insulated needle-bar by the wire K which is rolled up on a small wire so as to give it a coil. After it is coiled it is well to dip it in shellac varnish so that the current cannot short circuit through an accidental contact by the wire with the top of the base. It will now be seen that the circuit has two terminals, one being the base, and the other the needle point; consequently, whenever the point of the needle comes into contact with the work being tested, the current will pass through the work to the surface plate, and thence back through the base of the gage to the terminal G of the battery which is in contact with the inside of the base. Whenever the current passes through this circuit it energizes the magnets in the buzzer and causes it to

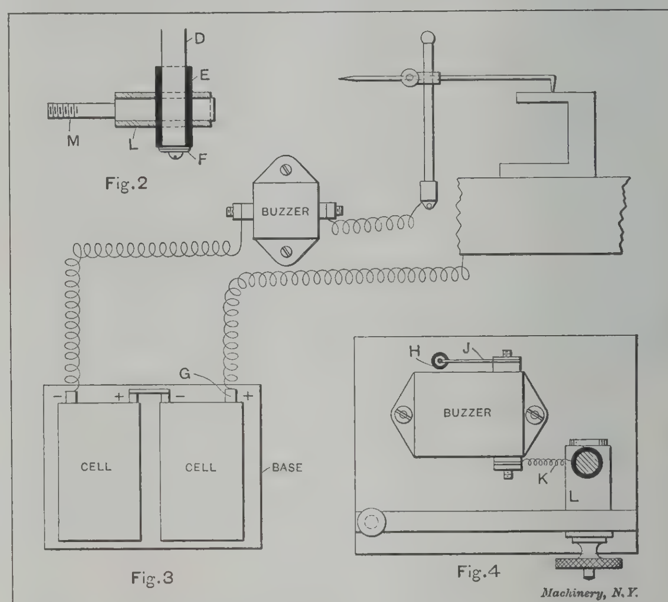

Fig. 2. Diagram showing Electrical Connections and Plan of Gage

give out a clear sound that can be heard several feet away. The moment the needle point passes to a low point on the surface of the work, the contact is electrically broken and the buzzer ceases to sound. At E, Fig. 2, is shown the hard rubber sleeve that insulates the needle-bar D from the base L. The usual form of binding device is used, of which the threaded stem M is a part. It is well to have a small shoulder on E so that the bar cannot slide down and make contact with the base of the tool, in which case it would run the battery down. It will be seen that no switch is required, as the circuit can only be closed through the needle-bar and needle.

The buzzer is secured to the top of the base by two screws, one at each end, and it does not require insulating from the base, as the binding posts are insulated at both terminals from the enclosing case. In trying the truth of a surface, as at A in Fig. 1, the foot of the work would be set up on parallels and the needle inverted with its point up; it can then be placed under this surface and indications taken in a location that would be difficult or perhaps impossible to see. For work in the lathe, the base of the gage can be set on the tool-post foot, and when the point of the gage strikes the work, no matter how lightly, the current will pass through the work in the chuck or on the face-plate to the lathe spindle, shears, and thence back through the tool-post foot and to the base of the gage, ringing the buzzer as the result, and the work can be trued accordingly. The same happens when an arbor is between the lathe centers, and no matter how fast it runs, the buzzer will sound when the point touches, when it is impossible for the eye to see it touch.

After the cells are inserted in the base, a metal bottom should be fitted so that they cannot drop out, and the work should be done so they cannot shake around in the base. It is also advisable not to leave the point of the needle long on the work as it runs the batteries down uselessly; but for all ordinary requirements they will last a very long time if a little care in this respect is taken.

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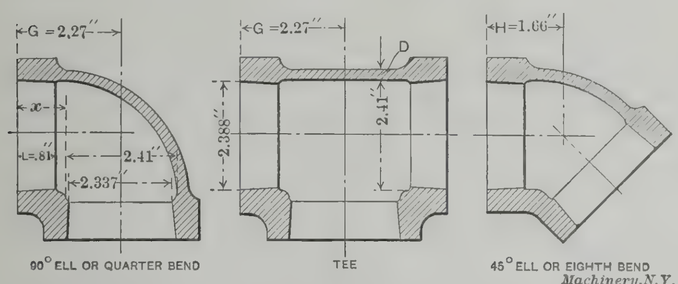
† George J. Murdock was born in New Berlin, New York, 1858, and received an academic and engineering education. He has been employed by the Hall Signal Co., New York; Western Instrument Co., Newark, N. J.; Manhattan Typewriter Co., Newark, N. J.; Sloan & Chase Mfg. Co., Newark, N. J., in the capacity of foreman, tool-maker, draftsman, foreman of instrument finishing work, etc. At present he is practicing engineering on his own account, making a specialty of instrument and precision tool work.

PIPE FITTINGS—THEORY VS. PRACTICE IN THEIR MANUFACTURE

F. W. BARROWS*

If I were asked what determines the thickness of ordinary, screwed pipe fittings, I should reply that the market price is now the final and controlling authority, all other essentials having long been dominated by this price; the weight being the conclusive test of merit. In theory the fitting should be strong enough to resist the internal pressure to which it may be subjected either by the fluid it is to convey or by the piper in "making up"; and the fittings now in the market have been proved, by numerous tests, to be not only strong enough to resist these internal strains, but have also successfully withstood the strains caused by changes of temperature, and by failure to "line up."

Using the formula $p = \frac{St}{r}$, in which p represents pressure; S, ultimate strength; t, thickness; and r, inner radius, and by substituting the values for ¾-inch gray iron fitting found in



Two-inch fittings for 100 pounds pressure, proportioned according to MACHINERY'S Data Sheet for June, 1905.
E (outside diameter of body) = 2.85 inches and tap diameter (outside at end) = 2.337 inches.
$E - 2D = 2.41$ inches or inside diameter of fitting, and $\frac{2.41 - 2.337}{2} = .0365$ inch clearance for tap.
$G - \frac{2.41}{2} = 1.065$ inch or X, and $X - L = .255$ inch, which is the clearance for the run of the machine or for making up. (Approximately three threads.)

Fig. 1. Sectional Views of Gray Iron Fittings illustrating Clearance for Threading and "Making Up"

the Data Sheet for June, 1905, giving dimensions for fittings to withstand 100 pounds pressure; p (bursting strain) $= \frac{20{,}000 \times 0.15}{0.55} = 5{,}454$. This product divided by 100, the pressure for which such fittings are guaranteed, gives a safety factor of 54.54. Through stress of circumstances, a line of ¾-inch piping, connecting a testing pump with its work, which was to be tested to 1,000 pounds, was made up with ordinary (100-pound pressure) gray iron fittings and brass check valves; and so well did it stand this extreme (water) pressure, that it was continued in use for some years. The pump used was a lever hand pump and the efforts to keep the pressure above 1,000 for the time considered necessary for inspection, caused the gage to show at times as high as 1,500 pounds.

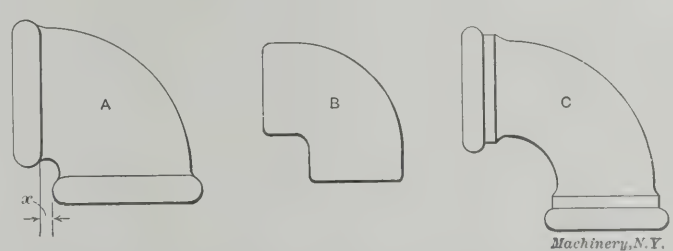
Taking t and r from the same list for 2-inch fitting, $p = \frac{20{,}000 \times 0.22}{1.205}$ = bursting strain of 3,734 (nearly), which would give, for this fitting, a safety factor of 37.34. This is without doubt a safe thickness.

Bronze (commonly called brass) fittings are usually made of yellow brass, which, strictly speaking, is not a bronze because it contains zinc, and for which the value of S may be safely taken (even for the miserable stuff used in "Rf" brass fittings) at 18,000; and t, as the patterns have an allowance for finishing, may be set down at 0.19. Substituting these values, the formula now reads: $p = \frac{18{,}000 \times 0.19}{1.205}$, which gives the bursting strain at 2,838, and a safety factor of 28.38 for this fitting, which factor, though less than that for the iron fitting, is still great enough for safety.

A line of six-inch piping, supplying steam from a boiler (gage pressure, 100) to an engine, ran along the ceiling and was connected, through a 90-degree elbow and a vertical pipe some eight feet long, to the engine. In the horizontal pipe there was an expansion joint of the ordinary, sliding type, and through somebody's oversight, this piping was used for several days without any stop for the expansion joint other than the rigidity of the elbow connecting the vertical to the horizontal piping. No accident occurred.

For 6-inch fitting, $p = \frac{20{,}000 \times 0.42}{3.41} = 2458$, giving a factor of 24.58 for safety. With the same factor as for 2-inch, this fitting would have been 50 per cent thicker and the 12-inch, with the 2-inch factor, would be nearly twice as thick as shown on the Data Sheet referred to in the foregoing. For a 6-inch bronze fitting, if designed on the theory that a 2-inch fitting is a good standard to base calculations on, the thickness of body would have been from 50 to 100 per cent (as the value of S might be varied to suit different mixtures) more than "good practice" calls for. Some exception may be taken to the stated value of S for the brass fittings, but in my opinion it is placed quite high enough when taking into consideration the large amount of poor scrap that is commonly used, and the shiftless methods of melting and pouring allowed in some foundrys, through either inefficiency or carelessness.

To go back again to the common practice, a little further consideration of what might be called the necessary attributes of a good fitting, will show that the fixing of the weight has also fixed, within very small limits, the thickness; which term as applied to fittings, means the thickness of body between thread bosses. The weight should be properly distributed in the length, and in the diameter of the ends, which must successfully resist the strain of making up. The length



A—Beaded brass ell with long ends, with clearance for tool at "x" to machine beads, and large fillets between bead and body that fitting may be readily finished all over by strapping, as is often required.
B—Malleable iron ell without bands or beads, known as a gas fitting. Because of their uniform thickness these castings are more easily made sound—a very good feature of this fitting.
C—Gray iron longturn or water fitting. This fitting, because of its long, easy curves (a prominent feature in all its different forms), is well adapted for piping intended to convey liquids.

Fig. 2. Types of Common Fittings

must be such as to permit a suitable length of thread and also room for tapping without any danger of the taps striking together at the end of the run, or of the piper's being able to screw the pipes in until they meet. The threaded ends and the tapped holes vary in size, and the piper is usually a strenuous individual who may be relied upon to accomplish this if possible. Then there remains a certain amount of metal which may be divided between the length of end bands and thickness of body, the inner diameter of which, fixed by the pipe size, is usually made slightly larger than the outside of the pipe to prevent any shoulder being formed in tapping.

One may vary the diameter of the ends, but after having become acquainted with the aforesaid piper and his trusty "Stilson," the inclination will be to increase this diameter, even at the expense of body thickness. Again, when one has once learned how easy it is to crack a cast iron tee or ell through the "corners," there will be a still greater inclination to enlarge the ends of new fittings. The beaded fitting is probably the best form for resisting this making-up strain, and most brass fittings are made in this form, but the beaded, gray iron fitting does not seem to suit the trade.

If the foundry is to produce good sound castings, at the minimum cost, the change of thickness where the tapping boss and the band join the body, must not be too abrupt, a requirement which will keep the end size down and thus limit the amount of metal which can profitably be used in strengthening the ends. Another reason for not reducing the end size—for small fittings especially—is found in the practice followed

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by nearly all manufacturers, of tapping these smaller sizes with straight taps—thus bringing the strain of making up more exactly at the end of the fitting. Some makers claim that small fittings tapped in this way are just as good as the others. The smaller sizes of pipe show up rather badly; Briggs' standard gives a good length of thread, nicely tapered, which allows for quite a variation in size of the tapped hole, but requires, for a solid die, too much thickness of stock; at least this seems to be the verdict of those who make solid dies, as they are, almost without exception, made too thin. (Can this be another question of cost?) The dies are also often made with greater taper than Briggs' standard in order that the thin die may cover as much variation in size as the standard does, and even if the fittings were tapped taper, the pipe cut with the commercial die wouldn't fit. It may be that the claim "just as good"—for straight taps—should be allowed to stand.

The thickness of the body may be increased by shortening the bands, but if carried to extremes, this would hurt the appearance of the banded fitting. The net weight may be increased by using cheaper material, but this would not *improve* the goods, and the quality, fixed by the ever-present need of keeping down the labor cost, is now about as poor as it can well be. Iron fittings must be soft, and brass fittings must be of a mixture which will cut smoothly, in order that the cost of tapping may not be increased by spoiled work. Labor cost saved by improved facilities, is frequently expended in increasing the weight, and thus causing greater sales. Some customers may demand that the material used show a certain tensile strength; this would, in most cases, mean better material, and the customer expects to, and does, pay a better price. Again he may require that they be tested up to some stated pressure, which would raise the price by causing the rejection of some pieces, not for lack of strength, but because of holes through the castings. If the test is made by water pressure, the fittings unable to stand the test at first will often be found, upon testing again after some hours, to be perfectly tight; the holes, too small to be seen until located by the test, after the first wetting, are soon closed by rust. Natural gas fittings are often tested to 1,000 pounds, and, to prevent leakage through the casting, they are boiled for hours in paraffine.

In brief, the qualities demanded by the trade have placed the ordinary fittings far above any theoretical strength, and the efforts to improve these fittings tend, not to change the weight, but rather to a better distribution of the metal, so that when the new fitting is placed on the market, the first and final question, deciding its success or failure, will be: "What does it weigh?"

* * *

The Patent Office issued 33,514 patents in 1908, and registered 6,029 trade-marks, labels and prints; 22,328 patents expired during the year. The total receipts were $1,896,848 and the expenditures $1,712,303. On January 1, 1909, the Patent Office had a balance to its credit of $6,890,726. The work on that date was current, except in five examining divisions out of 49, and those five have caught up with their work since then. Special attention is being directed to the classification of the 915,000 United States patents, the 2,000,000 foreign patents, and the 85,000 volumes in the library, which is expected to reduce the expense of examining applications by one-third, and to improve the character of the work. Commissioner Moore has requested Congress to use a part of the surplus earned by the Patent Office for the erection of a building suitable for its needs.

* * *

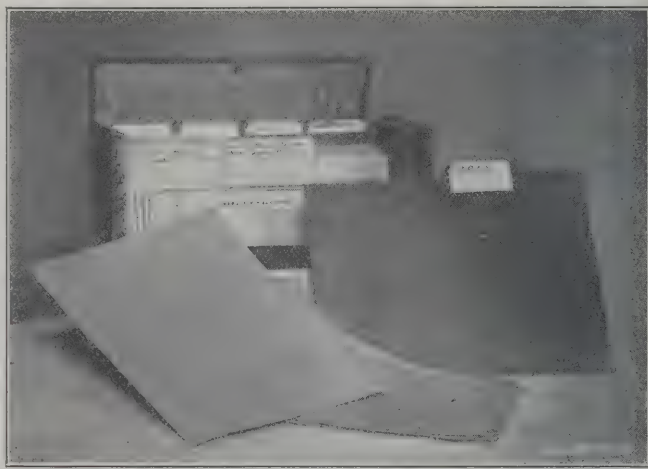
A sensation was created in marine circles by the announcement that the Curtiss steam turbines in the Southern Pacific liner *Creole*, built for the New York and New Orleans service, are to be taken out and reciprocating engines installed in their place. It is claimed that the vessel has not operated satisfactorily; her coal consumption is said to be excessive, 2,000 tons being required for the round trip between New York and New Orleans. The contract with the Fall River Shipbuilding & Engine Co., which built the vessel and turbines, called for a speed of sixteen knots an hour on a fixed maximum coal consumption. The vessel cost about $1,000,000.

MACHINERY'S DATA SHEETS—A WAY TO USE THEM

W. A. WARMAN*

I have preserved and used MACHINERY'S Data Sheets since their inception, and I shall offer a few suggestions from my experience concerning a method of filing them. Binding these sheets is unsatisfactory, as the index is never up-to-date. Again, few if any shops have occasion to refer to all the sheets, and dead material is undesirable, especially if it encumbers live stuff.

The most satisfactory arrangement I have found is that illustrated herewith. This is what is known as a transfer case for the open filing system. It consists of a box 5 by 8 by 10¼ inches, with a cover opening part way down each side, making it very easy and convenient to handle the sheets. The folders shown are made of heavy manila paper with a tab on one side. For convenience, these tabs are staggered. The folders can be made with three or five tabs if desired. The guide cards, with white tabs, are of heavy binder board. As shown in the illustration, the tabs are located on the guide



Filing Case for Machinery's Data Sheets

cards so that four extend across the filing case. Those on the folders are wider, being about one-third the width of the case.

The operation of the system is as follows: Divide the box into subjects with the guide cards, and subdivide the subjects with the folders. For instance, when filing the data on gears, mark a guide card *gears*. Then mark a folder *bevel*, one *miter*, one *spiral*, one *spur*, one *worm*, etc. The sub-classifications may be carried to any extent required for convenience. By this method the indexing is done once only, and the index is always up-to-date. The data pertaining to a class of any subject are in a folder convenient to handle, and fresh material is so easily added that special tables and data pertaining to one's own line may be made on standard size sheets, and inserted in the folders. Such sheets greatly increase the value of the outfit as a time saver.

MACHINE SCREW TAP AND BODY DRILL SIZES

Size	Threads per inch	Body Drill	Tap Drill	Size	Threads per inch	Body Drill	Tap Drill
2	56	43	48	8	32	18	28
3	48	38	44	10	32	9	20
4	46	32	41	12	24	1	15
5	40	30	36	14	20	c	10
6	32	28	33	14	24	c	6

I had a set of sheets shellaced for use in the shop. The shellac keeps them quite clean and they can be washed when soiled. After using the shellac, I found that celluloid lacquer was much easier to use. It may be applied directly to the sheets, while to avoid discoloration, they must be sized before shellacing.

As to the Data Sheets, most all that we have used have been very satisfactory. The only one on which I would suggest a change would be the tap drill list for machine screw taps. The list given herewith is very near for average machine shop work. It is certainly healthier for taps than the

* Address: Keller Mechanical Engraving Co, 570 West Broadway New York.

list given on Data Sheet Number 2. To devise a tap drill list with which an amateur cannot go wrong, would be an almost impossible task; so many factors need to be considered in determining the drill size that will give the best result. I do not see how any table of sizes for small taps can be used without variation, as conditions vary. The best one can do is to compromise.

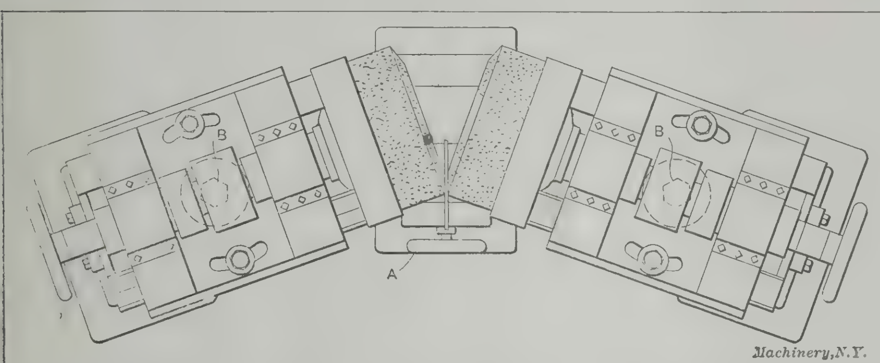
If a screw has little to do, what is the use of taking a chance of breaking a tap by forcing it to cut a full thread? The kind of materials must always cut a large figure in determining drill sizes.

* * *

GRINDING MACHINE FOR SKATES, ETC.

A machine that will grind metal bars on both sides simultaneously has been patented by Chetwood Smith of Worcester, Mass. (U. S. patent No. 930,626, Aug. 10, 1909). His machine is particularly adapted for grinding the blades of skates or in the formation of tools where the sides are to be tapered or ground on a curve.

Mr. Smith found that for successful operation, the axes of the grinding wheels should be at an angle to each other, as shown in the engraving, which is a plan view of his machine. The wheels are cup-shaped and beveled at their working edges to present frusto-conical grinding faces. The axes of the wheels are set at such an angle that the adjacent portions of



Grinding Machine for Skates and Other Parts Finished Simultaneously on Both Sides

the grinding faces are substantially parallel when the wheels are employed to grind the blade, the blade being supported on a rest which is made vertically adjustable by the hand-wheel *A*.

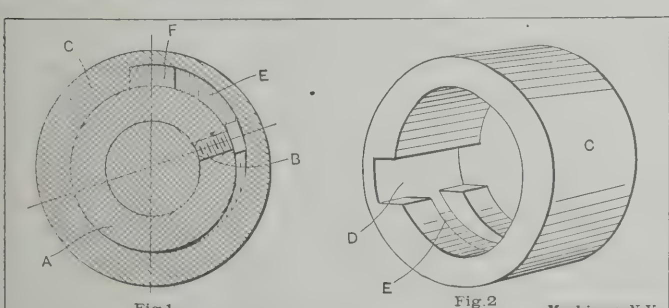
Each carriage has at its under side below the stud *B* a threaded boss and screw with a hand-wheel, which adjusts the carriage longitudinally of the base of the frame, thus adapting the grinding faces of the wheels to the thickness of the work or compensating for the wear of the grinders.

* * *

SET COLLAR FOR SHAFTS

A set collar with an effective retaining means, whereby the danger of its becoming loosened upon the shaft is eliminated, was patented by Israel W. Exley of Colville, Washington. (U. S. patent No. 930,169, Aug. 3, 1909.)

Fig. 1 is a cross-section of the assembled device and Fig. 2 is a perspective view of the locking collar.



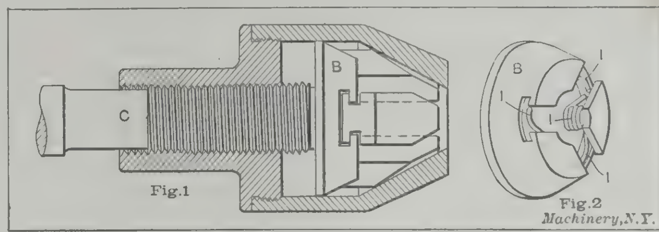
Set Collar for Shafts with Protector for Screw Head

After collar *A* is fastened upon the shaft by the retaining element *B*, collar *C* is slipped over it, the longitudinal opening *D* in the latter coming over the projecting head of *B*. The collar is rotated, bringing the head within the annular passage *E*, which has walls diminishing from its point of connection with the surface of the longitudinal passage. A wedge *F* is then inserted in *D*, and the collars *A* and *C* are thus securely locked upon each other, and the retaining element *B* effectively locked and held in position on the shaft.

* * *

DRILL CHUCK

Thomas J. Fegley and George O. Leopold in U. S. patent No. 932,259 (Aug. 24, 1909), assigned to North Bros. Mfg. Co.,



Drill Chuck with Radially-acting Jaws

Philadelphia, Pa., describe a simple and cheap chuck that will readily and firmly grasp a drill or other tool. A longitudinal section is shown in Fig. 1 and a perspective view of one of the jaws in Fig. 2.

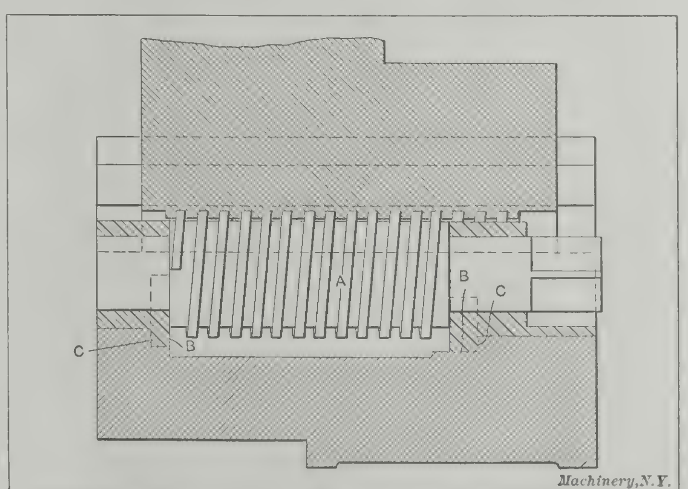
The operation of the chuck is as follows. On screwing the stem *C* into the shell, the disk *B* is forced toward the conical portion of the shell, which, in turn, forces the jaws toward each other against the pressure of the springs *I* (Fig. 2), closing the jaws upon the drill inserted in the chuck. By reversing the movement of the shell the jaws are released from pressure and the springs *I* will force them apart.

By making the disk hollow (Fig. 2) and mounting the springs on studs, the springs are held in position even when the chuck is dismantled.

* * *

CHUCK JAW SCREW MOUNTING

In U. S. patent No. 930,075 (Aug. 3, 1909) Albert P. Kern describes an improved mounting for the radially adjustable jaws of a chuck, which he has assigned to the Cincinnati Chuck Co., Cincinnati, O. The engraving is a section of one of the jaws, showing the operating screw *A*, and the sleeves Mr.



Hardened Chuck Jaw Screw Mounting

Kern uses for bearings. The sleeves are of hardened steel, each having a flange *B* engaging against the shoulder *C* of the body to prevent the sleeve from being radially displaced in its seat. Preferably the outer sleeve has a portion of its periphery cut away for providing clearance for the sliding jaw. The ends of the screws are thus given a hard steel bearing in the radial slot, so the greatest possible efficiency may be derived.

* * *

The government of Western Australia is about to undertake the construction of a railway line, 114 miles in length, connecting the Pilbarre goldfields with Port Hedland.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

RAILWAY MACHINERY

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We solicit exclusive contributions from practical men on subjects pertaining to railway machine shop practice. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

NOVEMBER, 1909

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

INDEX FOR VOLUME XV

MACHINERY was started September, 1894, the first volume containing only 192 reading pages and about the same amount of advertising. The fifteenth volume contains 1,000 reading pages and more than double that number of advertising pages. While the growth of MACHINERY has been somewhat unusual in the history of trade publications, it measures quite accurately the growth of the machine tool and kindred industries which the publication represents.

The index for Volume XV, engineering edition, comprises over 4,000 references and fills seventeen pages, type size slightly larger than the regular MACHINERY page, set in six-point, four columns to the page. Copies of the index of the engineering, railway or shop edition will be sent to subscribers on request.

* * *

PROGRESS IN SAFEGUARDING MACHINERY

The promoters of the national movement for providing safeguards for the dangerous parts of machinery to prevent the many distressing accidents to life and limb, should be gratified by the material improvement in this detail noticeable in machine design in the past two or three years. Comparatively few builders of engine lathes, for example, now neglect to cover the back gears and other gears with guards. The appearance of the lathe is improved, and a potential danger to the fingers of the operator is removed.

Purchasers of machine tools can materially accelerate the movement by insisting that all danger points be safeguarded. There is scarcely ever a good reason why gears should not be covered. A pair of spur gears is about the wickedest combination for mutilating fingers that can be conceived of; why should they be left uncovered when so dangerous? The proper shielding of all moving parts that can be covered without interfering with the function of the machine is essentially the designer's duty, and it should never be done as an afterthought when avoidable. This costs less in the original design with which it can be made harmonious, and what is most important, the guards integral with the machine cannot be readily removed by the workmen. Many machines have been wrecked or put out of commission for several days by having clothing or tools accidentally drawn between the gears, resulting in bending the shafts and even breaking the frames. By all means provide gearing with suitable covers, harmonious with the general outline of the machine. This remark is addressed to the designer.

* * *

LEARN TO DRAW

Every machinist who aspires to advance himself in his trade should learn mechanical drawing, or its rudiments, at least, so that he can make an accurate, understandable sketch. Drawing is a universal language, and the mechanic who cannot read drawings or blue-prints is not of much account nowadays. Picture writing is the earliest known form of written language, and the easiest understood. It is so comprehensive and simple that the most intricate ideas are made clear even to a child who perhaps cannot read. A sketch tells much that cannot be imparted by word of mouth. We never lose our wonder at the miracle and mystery of the repeated line—the repetition of the straight and curved that is the substance of all delineation.

A machinist would be ashamed to acknowledge that he could not read or write, and he should consider that he is equally at fault in his mechanical training if he cannot draw and read mechanical drawings. Drawing is an exceedingly useful accomplishment to a man who has to direct the activities of his shop mates. He can save time and convey clear ideas by resorting to sketches. The record can be made permanent, and is often a convenient reference long after it was made. The man who can make an accurate sketch of a machine part or a mechanism must have an accurate mental picture of it, and that means clear thinking. One great difference in men that makes some leaders and others followers is the respective capacity for thinking. The mere act of drawing accurately will stimulate mental activity wonderfully. It will usually make the individual study to understand things that in his conceit he believed he fully understood before. Drawing in this respect is akin to writing for the press. A man never realizes how little he actually knows of a process, method, or mechanism until he tries to describe it accurately in written words.

* * *

CATALOGUE FILING FOR SMALL CONCERNS

Every concern, large or small, that receives many catalogues listing machinery and other products likely to be useful in its business, should have some systematic method of filing them for ready reference. The average proprietor of a small shop probably will say that it is all right for the big concern to provide a catalogue file but, when you are superintendent, foreman, business manager and office boy all in one, there is mighty little time left for such fol-de-rol. Doubtless there is not much time left for systematic effort in the poorly managed business, but the time wasted in looking through a heap of papers for a catalogue that is dimly remembered and badly wanted will, if rightly directed, more than suffice for properly filing catalogues and price lists so that they can be readily found.

A simple and cheap method of caring for advertising literature is in use in the editorial department of MACHINERY that is recommended to those particularly who cannot afford a more elaborate system. First, a number of ordinary letter files was provided that cost at retail 25 cents each. These files were numbered on the back, beginning with 1 and filled with the catalogues on hand. Each catalogue put in No. 1 file has the number 1 written or pasted on its cover and those put in No. 2 file are marked 2, and so on. The obvious purpose of these numbers is to facilitate replacement in the proper file when removed. The date of receipt of all circulars and other advertising literature is written on them, thus 9/28/09. A card index of 3 x 5 cards is compiled, each concern represented having a card on which is written the number of the file in which its catalogue is stored.

Catalogues are filed as received, filling the new boxes without regard to matter on hand except when new literature from concerns already indexed is received, then the new matter is put in the old box and no change in the cards is made. No attempt is made to file in alphabetical order, but a small concern could preserve the alphabetical order without great trouble, and in that case the card index would not be necessary.

Another means for avoiding the cards is a list of the concerns represented in each file pasted on the back of the files. The common letter files are 10 x 11½ inches inside, and will store the average size catalogues easily, and if a little care is taken each file can be so filled as to leave very little waste space.

* * *

LIGHT AERONAUTIC MOTORS

The aeroplane has been aptly typified as "an engine with wings," meaning that the motor is the heart and substance of the heavier-than-air flying machine. No other vehicle is so dependent on its motive power: A motor boat will still float if its engine is disabled; an automobile may be run off by the side of the road and left until the repair man can be called; a motor-cycle can be propelled by foot power; but the aeroplane must at once leave its element and negotiate the best landing place available when the engine stops. A dependable motor is so necessary to the success of the flying machine that we are forced to conclude that until it has been developed into a perfected state the aeroplane will remain little more than a dangerous toy for a few bold experimenters to risk their lives in.

In the race to develop aeronautic motors that will fly, the effort has been made to excel in lightness of construction, and some of the resulting motors have been marvels of power per unit of weight. It now appears, in the light of experience, that the sacrifice of dependability to mere lightness has defeated the object of making a motor that will certainly fly. It is not sufficient that the engine be made so light and powerful that it can easily raise itself; it is of equal or greater importance that it continue in flight and develop full power so long as the operator desires and the fuel supply holds out. One flying machine experimenter says: "Three different types of light-weight aeronautic motors experimented with have proved more than unsatisfactory. While the machine easily flies and rises with each of these motors, none can be depended on to stand the strain of continued operation. This experience forced me to consider the building of a new motive power, meeting more efficiently the requirements of the new art. The manufacturers of the present-day light motor, in an endeavor to lighten the engine, lose sight entirely of the real function of the motor. In an aeroplane, continued, ever-ready and dependable power is more important than in an automobile for a hundred and one reasons."

The experiments of the Wright brothers indicate that very light or very powerful motors are not absolutely necessary. In the official test at Fort Myer, Orville Wright lifted and carried 1,300 pounds with an engine rated at less than 24 horse-power, at a speed of about 45 miles an hour. Comparing this with the Curtiss record at Rheims, France, in August this year (see October number) the difference in weight per horse-power is marked. The Curtiss aeroplane, loaded, weighed about 700 pounds and developed 63 horse-power, the weight per horse-power being about 11 pounds, while in the Wright aeroplane it was about 55 pounds per horse-power. The greater area of wing surface in the Wright machine undoubtedly means that less power is required for sustaining the load.

The correlation of power of the engine, the size and speed of the propellers, and the area and shape of wing surfaces to secure the highest efficiency will undoubtedly require many more experiments than have been made by the Wright brothers and others, and probably some strange discoveries will be made in the realm of aerodynamics.

* * *

CHAIN MAKING WITHOUT SCRAP

Practically all manufacturing operations are accompanied with more or less waste. The turning of logs into merchantable lumber, for example, is enormously wasteful, not 50 per cent of the cubic contents in the logs appearing in the finished lumber when worked up by the machinery in general use twenty years ago. It is true that considerable improvement has been made in eliminating waste since the advent of band saws and thin resaws that convert a much smaller amount of wood into sawdust than the old circular saws of a generation ago, but even with the highly developed modern wood-working machinery the waste still is large, and in the majority of wood-working operations it must so continue except in the case of veneering. So it is in the milling industry, and all along the manufacturing line with a few notable exceptions.

Machine shop operations consist of turning, planing, drilling, boring and milling, all of which remove metal from where it is not wanted, thus making the finished product by wasting material in chips. Cutting, bending and forming is done in presses, however, with little waste, and some press work has been so highly developed as to eliminate practically all scrap. The article on another page of this number (engineering edition) "Chain Making Extraordinary in a Scrapless Press Room" is a notable example in which the elimination of scrap in an automatically formed product has been carried to the limit. While the process is typical of similar processes for the cold conversion of metals in wire or ribbon form into merchantable products, none we believe has equalled this.

To convert a coil of cold steel ribbon into perfect machinery chain, hardened against wear without a particle of scrap except a trifling scallop at each end of the coil, is a triumph of manufacture, and when it is considered that the product is turned out automatically, and the finished chain is 95 per cent of the length of the steel ribbon, we figuratively take off our hat to the man or men who have made this astonishing feat possible. Remember that the product is not the light plumbers' chain made from thin brass stock, but is machinery chain in sizes from ½ inch to 3 inches wide, and in thickness of 0.045 to 0.250 inch. The large sizes are capable of transmitting heavy power.

That man is called a public benefactor "who makes two blades of grass grow where one grew before," and equal justice requires that we acknowledge our debt to the men who have made scrapless chain, screws, nails, and other useful products possible at a labor cost so low as to be almost negligible.

* * *

THE MASSACHUSETTS PLAN FOR INDUSTRIAL INSURANCE

In the August, 1907, issue of MACHINERY, an article was published entitled "Industrial Life Insurance and the Workman." In this article the great waste incident to industrial life insurance, as conducted by the large industrial life insurance companies, was pointed out, and in a short item in the September, 1907, issue mention was made of the law enacted in Massachusetts permitting the savings banks to conduct industrial insurance. It appears that the Massachusetts plan during the two years it has been in operation has proved successful, and many firms and industrial corporations employing great numbers of men have taken active interest in the matter by way of facilitating the spread of information relating to the methods employed by the savings banks. One of the latest large Massachusetts manufacturing corporations to introduce into its plant the plan of savings bank life insurance and old age annuities is the B. F. Sturtevant Co. of Hyde Park, Mass. A savings bank agency has been established within the works, in charge of a person furnished by the savings bank insurance committee of the Boston Chamber of Commerce. As industrial insurance is practically a necessity to the majority of industrial workers, this departure is a very important one, and it is to be expected that this form of insurance will be introduced into other states as well.

Under this system of savings bank life insurance, any savings bank is authorized to establish an insurance department for issuing life insurances, limited to $500 and annuities limited to $200 per year, to residents of Massachusetts. While the amount of insurance in any one savings bank is thus limited, the same person may take out life insurance and annuities in more than one bank. The most important feature of this system of insurance is that the cost is much lower than that charged by the large life insurance companies in the past, notably the Metropolitan of New York and the Prudential of New Jersey. The savings bank industrial insurance is conducted at actual cost, and all profits are returned to the policy holders. The causes of the high cost of the industrial insurance in the large companies has been high managing expenses, which for instance, in the industrial department of the Metropolitan Life Insurance Co. in 1904 were 42.08 per cent of all the premium receipts. In the same year the percentage of managing expenses to the deposits made

during the year in the Massachusetts savings banks was 1.47 per cent. These facts were disclosed during an investigation made in Massachusetts, and as a result of this investigation the law relating to savings bank life insurance was enacted.

Although the general public has not responded as readily to the advantages of life insurance as was expected, the response of the various industrial establishments, where the managements have done considerably towards presenting the advantages of the scheme to the employes, has been satisfactory. A large amount of savings bank insurance has been obtained at the leading shoe factories in Brockton and Haverhill, and at the Fore River Ship Building Co., Quincy, and the United States Shoe Machinery Co., Beverly, Mass. The success has been greatest where the employes are well paid and of an intelligent class. To facilitate making this class of life insurance known to the employes the literature on the subject is usually first distributed in the pay envelopes. After that a trained insurance man from the Boston Chamber of Commerce interviews all the men and women who have shown interest in the subject. The success of the plan has caused considerable interest among manufacturers in other states.

An interesting comparison between the savings bank insurance and that offered by the large industrial life insurance companies is given by the Massachusetts State Actuary in a recent publication, wherein he shows that under this system an old age annuity with the life insurance feature added, costs less than what the working man now pays for his industrial life insurance alone. If a man is twenty-five years old and pays to the savings bank $1.30 each month, and his neighbor of the same age pays $1.35 each month to the insurance company, then the savings bank depositor when he reaches the age of sixty-five will have no more insurance to pay, but will begin to receive an annuity of $100; his neighbor, however, will continue to pay $1.35 each month to the insurance company until he is seventy-five years old, and yet nothing will be paid to him as annuity at any time, but his insurance merely amounts to a given sum payable at death.

Some figures relating to the actual cost of insurance under this system may prove interesting. By paying $1 a month, a man twenty-one years old may secure for himself an annuity of $200 a year, commencing at an age of sixty-five, and continuing throughout life. A man twenty-five years old by paying $1.16 monthly for twenty years may obtain a life insurance of $500. By a payment of eighty-two cents a month for life, he can purchase the same amount of insurance, his family receiving $500 at his death whenever it may occur. Including, as this system does, the annuity plan at an age of sixty or sixty-five years, it is an efficient substitute for the old age pension systems adopted in England and Germany, and instead of making the pensioner a *dependent* for life, this plan makes the man who commences to save a small amount early in life, *independent* in his old age. Under our present industrial conditions the importance of this system can hardly be overestimated.

* * *

An extensive plan for a system of airship lines to be established in France is outlined in *Page's Weekly;* where the capital for permanent structures and equipment is to be had is not explained. In view of the fact that service of this kind can hardly be expected to be financially successful, this most important consideration seems to have been given too little attention. Five airships, it is stated, capable of carrying from eight to twenty passengers besides the crew, will be built, and four lines will be immediately operated. Three stations, it is stated, are practically ready (?), and that of Rheims will be ready within two months. One line will extend northeast from Paris, another southeast to Lyons, another southwest to Orleans, Bordeaux and Pau, and a western line to Rouen. A similar company has been formed in Germany. It is stated by the *Practical Engineer* that the capital is 3,000,000 marks and that two ships are being built by the Zeppelin company, each capable of carrying the necessary crew and twenty passengers, the cost per ship being $140,000. No attempt is made, it is stated, to *estimate the profits:* this seems to be the most sensible part of the venture.

BOARD DROP-HAMMER DESIGN

H. TERHUNE*

About two years ago the writer had occasion to redesign an entire line of drop-forge machinery for a large drop-forge plant in the East, using board drops exclusively. In years past the use of these hammers has been severely (and justly) criticised because of the high cost of upkeep. For some reason the builders of these machines have neglected to keep the design up to the demands put upon the machines. Having been designed mostly for straight work, they often fail when forging four- and six-throw crank-shafts, automobile front axles, or any other kind of work requiring a lot of "break-down" (bending into shape) work.

So serious have been the repair bills on this class of work that many drop-forge plants have adopted the system of using two sets of dies, one to break down and another to finish, so that the impressions in the die blocks can be placed more central in the hammer. This not only entails extra cost for dies, but the tying up of an extra hammer as well; whereas, if the hammer had been properly designed to withstand the additional strains put upon it due to the breaking down, as well as wide enough between uprights, the work could have been done in one machine at a much less cost; the break-down being done at one side, and in the same die block as the finishing impression.

It is the side thrust that causes so much trouble with the piston rod and packing gland of the steam hammer.

Economy of Board Drops

For forgings up to say 300 pounds, the writer does not believe that a more economical way can be found to forge them than in a properly designed board drop hammer. The power consumption is extremely low. In one plant using 45 board drops varying from 400 to 3,000 pounds or a total falling weight of 50,700 pounds, even with a bad arrangement of jack-shafts, these hammers together with 23 trimming presses and kindred machinery are driven by two motors of 75 and 100 H.P., respectively, and yet there is power to spare. For convenience let us assume that 40 H.P.—a low estimate—are used on the presses and other machinery; this leaves 1 H.P. for every 375 pounds of falling weight.

Almost every builder of steam drops recommends a boiler plant of at least 0.75 H.P. for every 100 pounds of falling weight. It is true that a steam drop will do more work in a given time for the same number of pounds falling weight than a board drop, but this is not so important when we consider that the best furnace to-day will hardly keep a board drop constantly going. Besides, what would become of the average drop forger if kept constantly before his fire for a full day of nine hours?

General Construction of Board Drop Hammer

To meet the requirements of an up-to-date drop-forge shop, the hammer, of which a front and rear view are shown in Fig. 1, was designed. It is an almost indestructible machine, the capacity of which seems to be limited only by the ingenuity of the die sinker. In the design many new and commendable features have been introduced.

The bases are of cast iron and in one piece, a weight ratio of 15 to 1 between base and hammer being adopted; that is, if the hammer weighs 2,000 pounds, the base would weigh 30,000 pounds. A shoe or "sow" of 0.45 carbon steel is keyed and doweled into the base, and the die openings planed into this. The recess in the base for the uprights is planed straight through, assuring a permanent alignment, as there is a bearing the entire width of the uprights.

Fig. 4 shows the section of upright used by most builders since board drops first came into use. As work became more and more severe, and uprights failed, nothing was done, however, but to increase the cross sectional area till the center became very porous, an even section of metal being impossible. The V's too have failed, and in every case the break was perpendicular to the surfaces in contact (see Fig. 4). These failures, together with a practical and theoretical knowledge of conditions led up to the form of upright shown in Fig. 5, which has nearly an even section of metal distributed so as to

* Address: 114 Brook St., Hartford, Conn.

better withstand the shocks brought to bear upon it. The V is backed up by a beam of the depth A and the thickness B, and any direct thrust that is perpendicular to the apex of the V is taken up by beams of depth C and thickness D.

Adjustments

It often happens in drop forge work that the dies do not match exactly sidewise, and some adjustment is necessary to bring them in line. The top die is generally doweled securely onto the hammer, and some drop forge plants use double keys for holding the bottom die in the shoe. One taper key is driven in from the front, and another taper key is driven in from the rear. In adjusting the location of the lower die relative to the upper one, all that is necessary is to back one key out and drive the other one in. This form of adjustment, however, is rather limited, as the taper of the keys must not be too great, or the keys will not remain in place; it also adds an extra piece to fit and possibly jar loose.

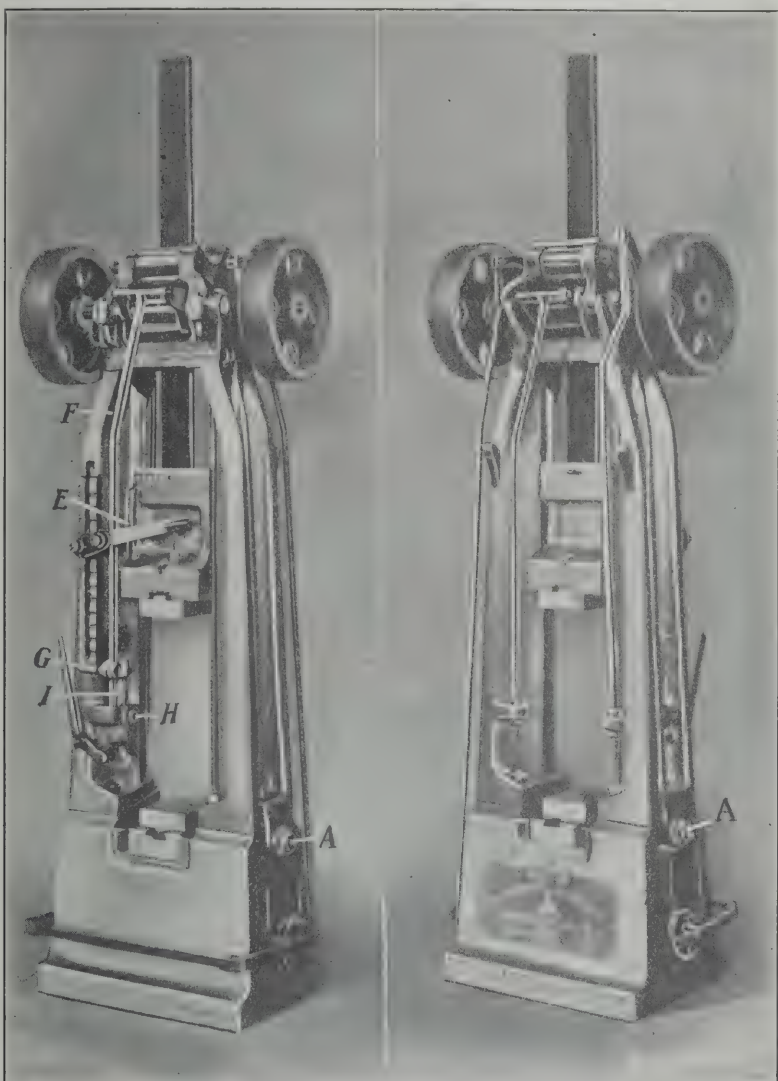


Fig. 1. Front and Rear Views of Board Drop-hammer of Rigid Design

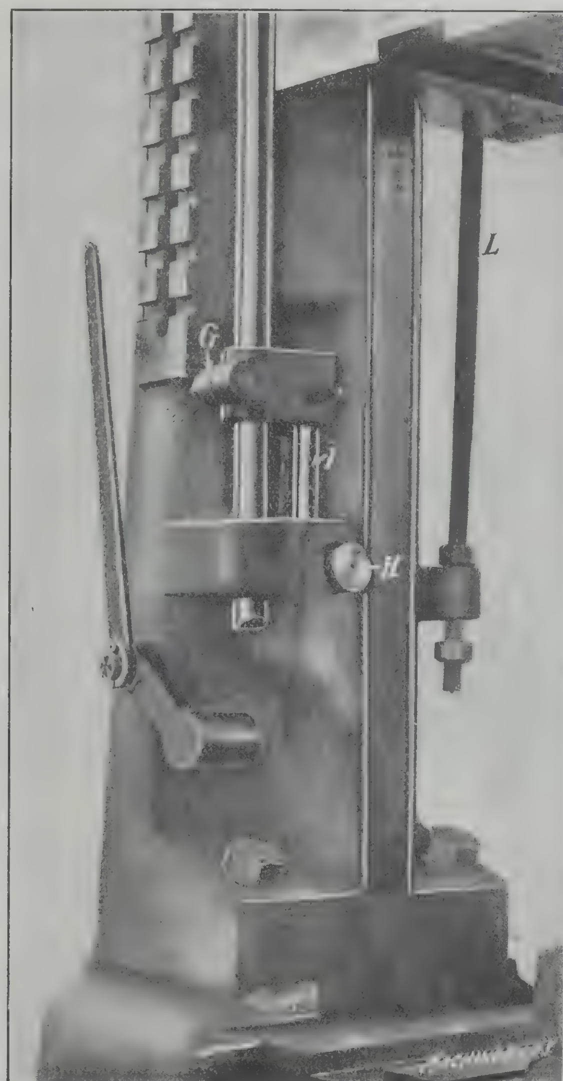


Fig. 2. Automatic Knock-off Arrangement

A better method of adjustment is to move the entire upper structure sidewise on the base by means of an adjusting bolt; but this bolt has, possibly, been one of the greatest annoyances of the board drop in years past. For a long period all makers used practically the same construction, consisting of a set-screw passing through a nut inserted in and fastened to the base, the point of the screw bearing against a projection of the upright. The hammering action of the upright, however, is very severe, especially on break-down work, and the point of the adjusting screw soon becomes upset so that it can neither be removed nor used for adjusting the uprights.

In the present construction, therefore, a bolt with a T-head has been laid horizontally in the recess for the upright cast in the base. The T-head is let into the base, so that the bolt cannot move relative to the base casting. The round part of the bolt rests on a finished surface in the recess, and a finished groove is provided in the upright to fit over the bolt; the lower part of the upright thus straddles or forks over the body of the bolt, as shown in Fig. 6. The collar-nut on the end of the bolt is shown at A in Fig. 1, this nut bearing against a boss on the upright. One bolt of this kind is provided for each upright. In adjusting, the hammer with upper die is let down until the faces of the dies come together. Then the base binding bolts are loosened, and also one of the upright adjusting bolt nuts. The other adjusting bolt nut is tightened, thus moving the entire upper structure—uprights, hammer and head—to the right or left, as the case may be, until the dies are properly matched. Then all parts are again locked into place. The moving of the entire structure is quite common in board drop hammer designs and is considered good practice, especially when the base binding bolts are at an angle, as is the case in the present hammer, as this draws the uprights apart and back against the adjusting bolt nuts.

Notches are cut in the collar of the nut, as shown in Fig. 3, and a flat spring is fastened to the base and brought to bear in the notches, this forming a positive lock and an easy means of adjustment. With a special thread on the bolt, an adjustment as fine as 0.0028 inch can be had.

The trouble due to constant vibration causing the uprights to creep together and pinch the hammer at the bottom is overcome by setting the base binder bolts at an angle, thus keeping the upright back against the upright adjusting bolt nut. The adjustment for different heights of fall is made by a bracket clamped to a modified form of rack in any desired position on the left-hand upright. (See Fig. 1.) The roll releasing lever E, better shown in Fig. 7, allows the friction bar F to release on the up stroke without shock or noise. The automatic knock-off H is best shown in Fig. 2.

Adjustment for different thicknesses of dies is made through the adjustable dog G, carrying a stop pin I,

the latter resting on a flattened surface of the knock-off H, which has an elongated hole through it. The side of the hammer is beveled to fit the beveled end of the knock-off H. As the hammer descends the knock-off is forced back, allowing the stop pin to fall through the elongated hole. For thick dies the stop pin is set forward, and, as shown in the line engraving Fig. 8, consequently falls earlier. In this line engraving, C is the elongated hole in the upright allowing adjustment for the stop pin; the pin is shown set for thick dies and it is moved back in the slot for thinner dies. The elongated hole through the knock-off is indicated at D. As the hammer descends it is evident that when the knock-off is forced back, the stop pin falls through the slot in the knock-off and allows the friction bar to drop, and thus the eccentrics on the lifting rolls are brought into contact with the lifting board. The hammer then rises until the hammer pin, which is made of wood in order to lessen the impact, comes in contact with the roll releasing lever, which raises the friction bar and thus releases the rolls.

As shown in Fig. 8, the stop pin rests on a surface the width of which equals y. Should the stop pin be moved to

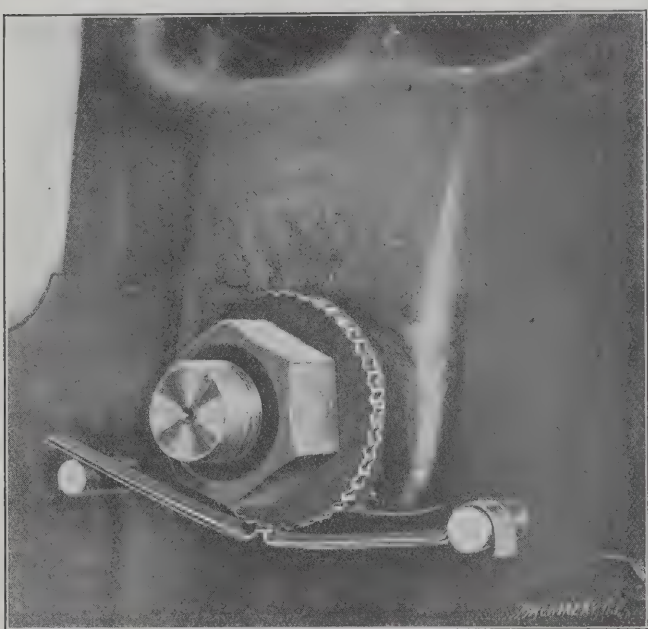
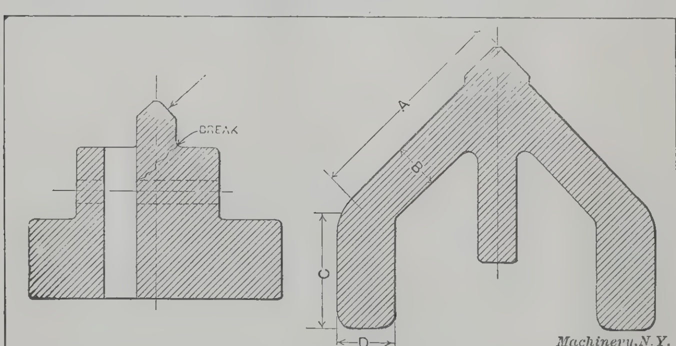


Fig. 3. Locking Arrangement for Upright Adjusting Bolt Nut

the left to the end of the slot in the upright, the knock-off evidently would have to be forced back a distance equal to z before the friction bar could fall. As the side of the hammer and the front of the knock-off are beveled only 5½ degrees, the hammer must travel a considerable distance to force the knock-off back 1⅛ inch, which is its extreme travel.

Even if the drop forger is not careful in setting the knock-off, little can be lost in having it act too early, unless



Figs. 4 and 5. Section of Uprights of Usual Type and of the Type used in the Hammer shown in Fig. 1

at a very short fall, because the hammer has a velocity of a free falling body, having fallen several feet, while the friction bar starts from rest when the knock-off releases it. The friction bar should be heavy enough to throw the rolls against the lifting board with force enough to lift the hammer readily. The best condition is to catch the hammer when rebounding from the dies.

It will be noticed that there is no provision made for preventing the knock-off from turning around its own axis. Provision to prevent turning was made on the first hammer built, but it was found unnecessary, as the weight of the friction bar resting on the flattened surface always keeps the knock-off

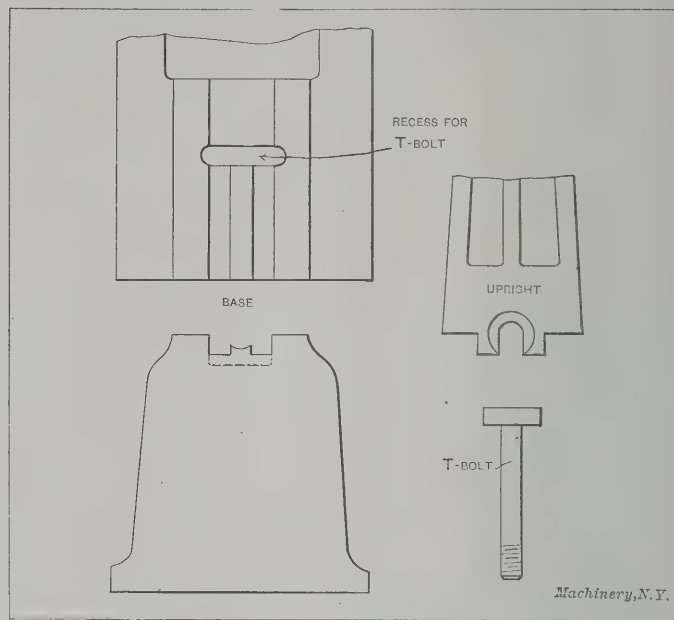


Fig. 6. Details of Sidewise Adjustment of Uprights

from turning when the bar is up, and as soon as released, the pin passes down to the slot in the knock-off, making turning impossible.

The knock-off stop is counterbored instead of being bored clear through. The reason for this is that the impact of the hammer would be likely to shear off the taper pin. With the construction shown, the pin has nothing to do but overcome the impact and pressure of the spring, and even this impact is lessened by fiber washers which act as cushions, as well as by a safety cotter pin which would act in case the taper pin should fail.

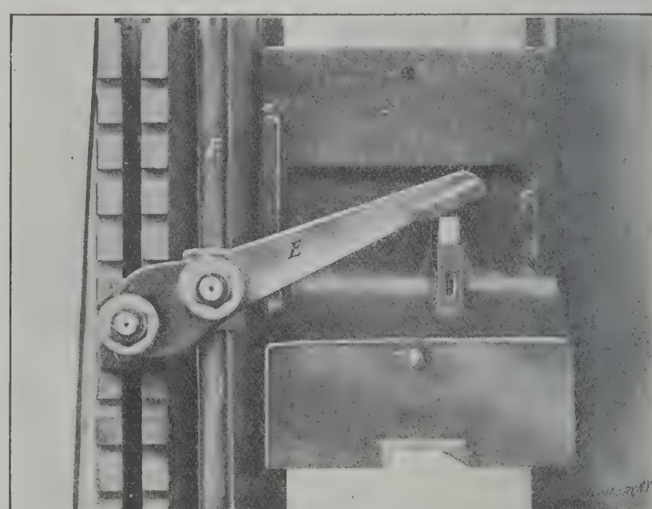


Fig. 7. Arrangement for Adjustment for Different Heights of Fall

When the hammer pin comes in contact with the roll releasing lever, as previously mentioned, thereby raising the friction bar and releasing the rolls, the hammer again falls and will continue to run automatically until the treadle is released. At this time it comes to a rest on the top of its stroke, and is held there by board-clamps K, Fig. 9, located above the rolls out of the way of any oil that may work out of the bearings. By a greater or less depression of the treadle, any blow may be struck regardless of the set fall. The hammer can also be stopped at any point when falling, without injury to the machine.

Head Construction

Fig. 9 gives a good idea of the head construction. Both lifting rolls, as well as the board clamps, are mounted on eccentric sleeves, the front one of each being intended for operating and the rear one for the adjustment necessary, due

to the rolling down or wear of the board. This feature is one of the most important in the whole construction as a perfect alignment of the rolls is always assured, regardless of how careless the operator may be. The adjusting bars *L* are carried down in the back of the uprights through lugs cast on them, and locked within easy reach of a person standing on the floor. (See Fig. 2.) Adjustment for the wear of the board can thus be made in a few seconds, whereas usually on all drops offered to the trade a ladder is necessary for reaching the set-screws located behind each end of the rear roll bearing. It is then a mechanical impossibility to ever get the rolls and clamps parallel, with the proper amount of friction, while the drop is running.

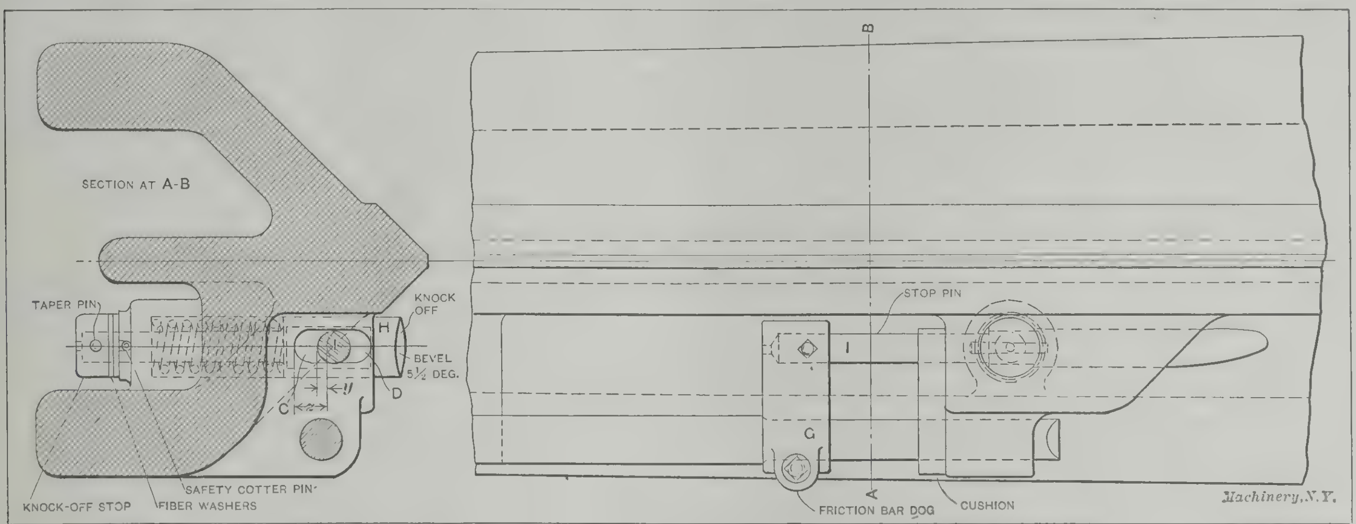


Fig. 8. Details of the Automatic Knock-off Arrangement

An even pressure must be brought to bear across the entire face of the board, or a rapid wearing away will result, and many times this causes it to split. A double pressure on one side also has a bad effect on the bearings.

Seasoned maple boards have been found to stand better than any other kind of wood or metal. Paper fiber has been tried with fairly good results—but as yet the cost of this material is prohibitive. All running bearings of the hammer illustrated are exceptionally long, bronze bushed and provided with large oil reservoirs.

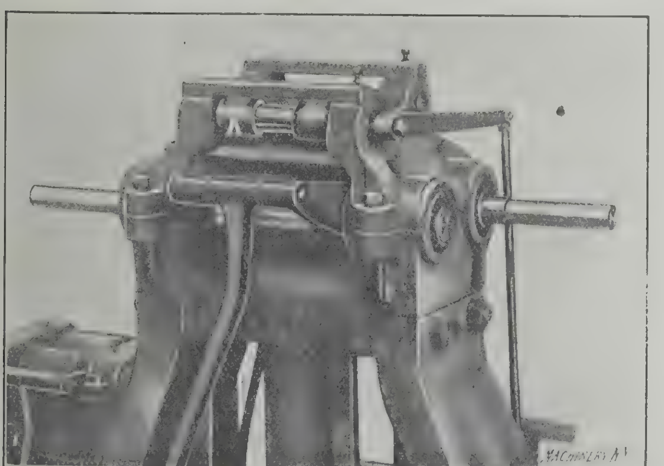


Fig. 9. Head Construction of Board Drop-hammer

Fig. 10 shows the foundation construction, which, like the ratio of 15 to 1 between base and hammer, was adopted after a long and varied series of experiments. The concrete mixture is made up of three barrels of stone, two barrels of coarse sand, and one barrel of cement. To meet the various classes of work that comes into the average drop-forge shop, these hammers were built very wide between uprights, *viz.*, 400-pound hammer, 12 inches; 800-pound, 14 inches; 1,200-pound, 17 inches; 2,000-pound, 20 inches; 3,000-pound, 24 inches. It does not seem practical to build board drops larger than 3,000 pounds falling weight. The field in which heavier blows than this are required is best covered by the steam drop and the hydraulic press.

THE MAKING OF AN ACCURATE LEAD-SCREW

In a paper read before the Institution of Mechanical Engineers, of Great Britain, by Mr. H. F. Donaldson, an incident is related showing the pains which are sometimes taken by mechanical men to accomplish their ends. The author of the paper states that some years ago he visited certain British works where it was claimed that micrometer screws were produced with exceptional accuracy. He there had a conversation with one of the members of the firm who claimed to have produced, by his own efforts, an accurate master screw upon which the accuracy of all the firm's subsequent work of this character depended. This man first cut a screw as accurately as possible by the common methods, and he then shut himself in a room, the temperature of which was constantly kept nearly at the heat of the human body, so as to in this way by artificial means minimize the effect of the heat of his body on the work in which he was engaged. His screw had a square thread and was about twelve inches long;

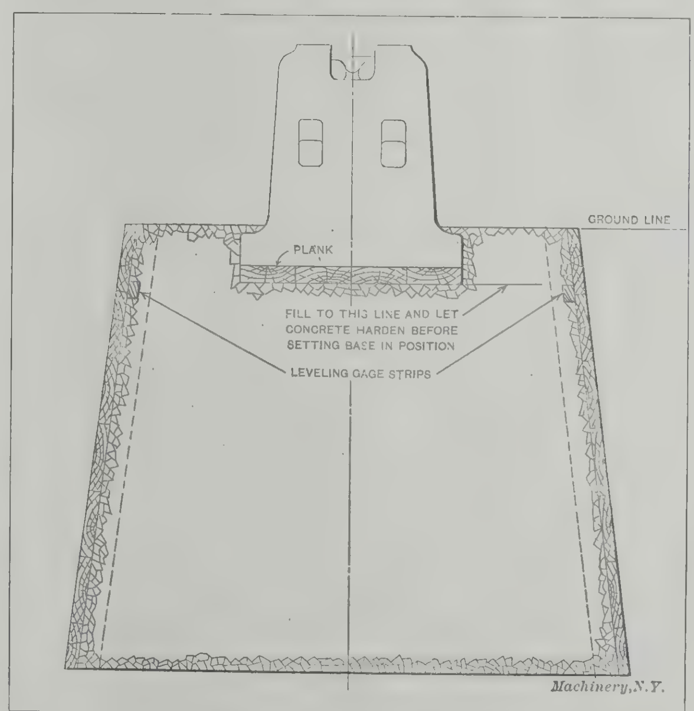


Fig. 10. Foundation of Drop Hammer

when the temperature of the room had been brought to a level as high as he considered he could stand, he shut himself in the room and proceeded to measure short lengths of the whole of the screw and lap the inaccuracies on both sides of the thread until he secured, as near as could be obtained, absolute accuracy in the screw. He remained in the room until he had gone over the whole length of both sides of the thread which required about twenty-four hours, when he came out of the room with the screw in its finished state.

SOME CAUSES OF BELT FAILURES*

G. S. BAKER†

Nearly every large manufacturing plant is constantly making changes and improvements in its machinery for the sake of effecting greater economy in its output. Strangely enough, many of our largest manufacturing plants, though equipped with most modern machinery, have most inefficient methods of installing belting equipment. There seems to be a general feeling that belting a machine is something that everybody understands and something which needs no particular study or attention. The result of this indifferent attitude toward belting and its proper installation, has been constant extravagance in the belting equipment of plants where the greatest possible economy is followed in other directions.

The causes of belt failures are many. In some instances the cause may be traced direct to the manufacturer of the belt, who has not furnished in the goods delivered the qualities which he should. But, let us assume, that only the best belting is bought and delivered, and then analyze why the best belting, wrongly installed, will have need for frequent replacement. Under such conditions the causes are two-fold: First, belt failures are often due to a defective working out of the underlying principles of practical belt transmission; and second, belt failures are often the result of the selection of an improper type of belting for the particular kind of work to which it is to be put.

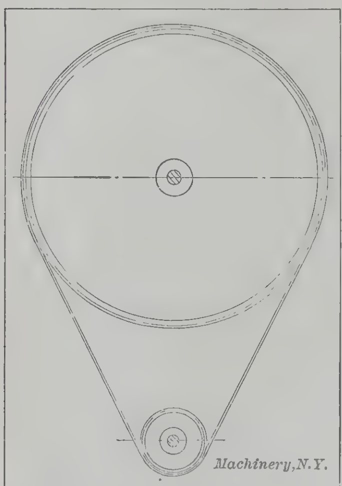


Fig. 1. Drive from Large to Small Pulley, showing Decreased Arc of Contact

We shall, in this article, attempt to show how a large percentage of the unnecessary costs of belting could be eliminated by following out three suggestions: First, by foreseeing and modifying the mechanical and architectural plans in the building of plants, so that they will conform to the most modern principles of practical belt transmission; second, by modifying pulley conditions in a plant already built; and third, by the selection and proper installation of the right type and size of belting for the particular machine and pulley upon which the belt must operate.

Very often slight changes in transmission conditions would save great losses of time on many types of machinery in many of our factories. Here for example are some of the common mistakes in transmission which could easily be rectified, if attention were called to them.

Allowing too short centers between the shafting. This practice works havoc with the belt where the load is heavy. Owing to its limited length, the belt does not sag on the top side, as it would when driving from the bottom of the pulleys, which is the correct way; therefore it becomes necessary to draw the belt very tight to avoid slippage, thus straining it and adding to the frictional resistance in the bearings. When the diameters of the driving and driven pulleys differ to any extent, as shown in Fig. 1, there is a material reduction in the arc of contact on the smaller pulley, as the distance between the centers of shafting is lessened, and as the driving power of the belt, in a measure, depends upon the area of contact between the belt and pulley surfaces, the advantage of increasing the distance between centers is apparent.

Installation of pulleys which are too small. A slow-running belt must be heavy if any strain is put upon it. It must also be wide to get the proper area of contact to insure it against slippage. Where small pulleys are used, the above condition is doubly true. Were the pulleys at their installation enlarged proportionately, they would still give the same number of revolutions, but the belt speed would be increased, the grippage area increased and a narrower and lighter belt could be used. Such a belt will invariably outlast a shorter, heavier and thicker belt. In determining the minimum diameter of pulleys to be used with single and double belting, it is necessary to take into consideration the width of the belt to be used, belt speed and horse-power transmitted. In a very general way it may be said that it would be well, whenever possible, to have the pulleys on which single belting is to run not less than 8 inches in diameter, and those for double belting not less than 12 inches in diameter.

The avoidance, as far as possible, of quarter-turn drives. Quarter-turn drives (Fig. 2) bring about one of the hardest conditions found in belt transmission. This character of drive can often be avoided in one of three ways: (a) By installing two loose pulleys so that the belt will operate over them, as well as over the regular driving pulleys, as shown in Fig. 3. The loose pulleys must correspond to the tight pulley on the same shaft, and be so placed that the crowns of all four pulleys in plan would form a rectangle. The advantage of this arrangement, generally speaking, may be said to be in the fact that when the belt operates at a quarter-turn with the delivering faces of the driver and driven pulley plumb, the belt does not get the full degree of contact with the pulley which it does with the loose pulley arrangement, which gives for pulleys of the same size a full 180 degrees contact. This condition, of course, makes for greater driving efficiency of the belt than when the area of contact between the pulley surface and belt is lessened by the quarter-turn arrangement.* (b) By the use of a right-angle transmitter. (c) Possibly by installing two idler guide pulleys on the top side of the belt.

An avoidance of the use of small pulleys on extra long center drives. This condition taxes the tractive power of a belt to the utmost. Under such conditions it is necessary that the belt be kept under a certain tension at all times. The result of this is usually either constant taking-up during damp seasons, or lengthening in dry periods.

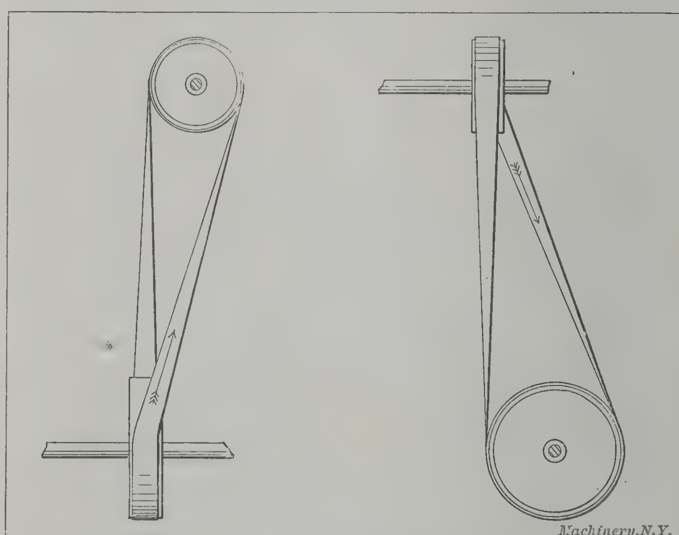


Fig. 2. Quarter-turn Drive showing Distortion of Belt as it leaves Pulley

By so installing the belt that the slack side is above and the driving side on the bottom of the pulleys. If this condition is reversed, the slack side being below, as shown in Fig. 4, the arc of contact of the belt with the pulleys is materially lessened.

Types of Belting for Different Classes of Work

Perhaps the most common cause of wastefulness in belt transmission is the selection of improper types of belting for particu-

* For additional information on this subject, see the following articles previously published in MACHINERY: Apparatus for Measuring the Slip of Belts, May, 1908; Loss of Velocity Ratio Due to Belt Elasticity, January, 1906; The Manufacture of Belting at the Schieren Factory, May, 1906; Tests of Belt Preparations, March, 1906; Horse-power Transmitted by Belts, July, 1906; Belting, June, 1905; Belt Drive for Shafts at Right Angles, June, 1902; Belt Drive for Three Pulleys, March, 1901.

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* Where the quarter-turn drive cannot be avoided because of lack of room or for other reasons, the straining of the belt can be minimized by lacing the joining ends so that the flesh side of one and the hair side of the other is out. This method was described in the February, 1899, number of MACHINERY. As will be understood, when a belt is placed over the pulleys in this way it is not twisted any more than with the common arrangement, for what was a quarter twist one way becomes a quarter twist in the other direction when the belt end is turned half way around. The advantage of connecting a quarter-turn belt in this way is that there is equal stretching of the belt on both sides, as a given point on one side of the belt is first on one side and then the other of the pulleys for each revolution, whereas with the usual arrangement all the stretching occurs on one side.—EDITOR.

lar classes of work or machinery. We cite in the following a few instances where practical mechanical knowledge of conditions should govern the selection of the belting.

Drives with varying loads should be equipped with belts that have an abundance of elasticity and which are capable of retaining it. The elastic qualities should be such that upon the relaxation of the load, the belt will go back to its original state. Another instance where elasticity has great bearing upon the selection of the proper type of belting is in connection with quarter-turn belts. Here the belt must be able to form a long side and yet be elastic enough to insure of it not becoming permanent.

On drives where there is a long distance between centers, it is necessary that the belt be absolutely uniform and have

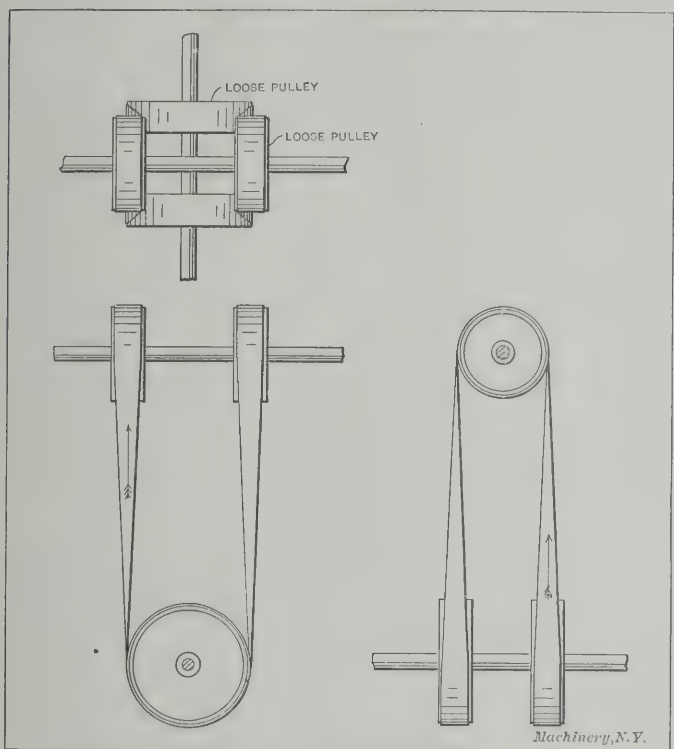


Fig. 3. Four-pulley Drive for Eliminating the Quarter Turn

perfect balance throughout. Unless a belt is procured which contains these qualities, its tractive powers and its driving powers will be materially reduced. Its life will be short and it will be continually running off the pulleys. Nothing but the best woven types of textile belts should be used on this character of drive, or leather belts made from absolute center stock. Often textile belts are selected for use with shifters. This is a mistake and should never be done, unless roller shifters are used. In the event that a belt is wanted which is to carry a heavy load, and where it is necessary that the belt should be kept tight at all times, it is always well to select a belt sufficiently heavy to give it a large factor of safety with regard to tensile strength.

As to the Arc of Contact

On the drives where the arc of contact that the belt has with the pulley is small, the transmitting efficiency of the belt will depend mostly on its width, since only in this way can an approach be made to the proper area of contact. Tensile strength, under these conditions, has very little to do with the horse-power the belt will transmit. The horse-power depends almost wholly upon the speed at which the belt travels. The area of contact of the belt with the pulley should, however, be large enough to prevent slippage.

Starting Machines with Full Load

One blunder very often made by the engineers of large plants, which plays havoc with the belting, is the starting up of machinery with the full load on. The belting is then required to transmit at a speed of, say, 100 feet per minute, the full amount of horse-power that it was designed to carry when running at a speed of, perhaps, 2,500 feet per minute. Unnecessary strains of this sort are among the prime factors which cause belting to go to pieces.

Effect of Water and Dampness

Another condition which is a large factor in belting difficulties, is water and dampness. To meet conditions of this sort, selection of the proper type of belting is of first importance. Dampness is, without doubt, the cause of more belt replacements than any other condition. While water itself may not splash on the belt, or the room in which the belt is operating may be free from water, nevertheless the action of dampness will often work havoc with belting. Dampness, unless the leather is specially treated to withstand its action, will cause the very best of leather belting to stretch, run crooked and in many cases open up the laps and piles. Belting at rest is affected much more by the action of moisture than when driving, as the frictional heat generated by the belt when driving tends to keep the belt dry. The problem of waterproofing and damp-proofing belting is a very important one at the present time, as our largest factories at the present day are being constructed of reinforced concrete and cement blocks. It is a well-known fact that unless special precautions are taken, as is seldom the case, that it is next to impossible to keep a factory constructed in this manner free from dampness, especially in warm seasons when no heating system is in operation. Since so many of our factories are being constructed in this manner, it means practically the dawning of what may be termed "the water-proof belting age." Dampness will penetrate readily through concrete walls. In one instance, which the writer recalls, underground concrete conduits were built in which the driving pulleys were to operate. The object of this idea was to save space by putting these belts under the floor, and also to get solid bearings for their shafting. The superintendent of this factory desired to use untreated, flat leather belting. He claimed that there would be an absence of water and moisture in conduits of this sort. It worked out, however, that the dampness from the ground penetrated the concrete walls and made the place very unsuitable for belting which had not been specially waterproofed.

As to Fasteners

Seldom does the question of belt fasteners receive the attention that it deserves. Almost invariably the complaint registered against the belt because it has torn out where joined, reflects more upon those who had charge of the installation than upon the belt with which fault is found. In determining the type of fastener to use, consideration must first be given to the mechanical conditions under which the belt will operate. If it runs under a tightener or drives from both sides it fol-

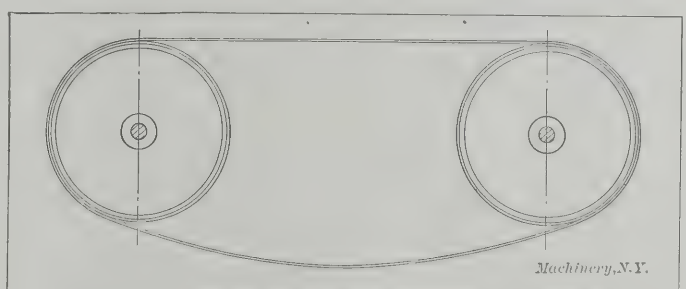


Fig. 4. Belt driving on Top Side, showing Decreased Arc of Contact

lows that the joint must be of the hinge or flexible variety, or the belt made endless, and under these conditions we must eliminate from consideration some types of fasteners which are very satisfactory where the belt operates on free open drives. In the selection and application of fasteners, textile belting calls for even more care than does leather. The punching of a hole which is too large or too close to the end frequently results in the fastener tearing out. In punching a hole in leather belting you weaken it only to the extent of the material removed, but a like operation on textile belting goes further in that it severs many of the interwoven strands and weakens the construction. The aim, therefore, should be to make the holes as small as possible and to place them at regular intervals. In preparing the ends of a belt for lacing or fastening, invariably use a square so that the ends will be at right angles with the edges of the belt. It has often been found, where fasteners do not give entire satisfaction, that this condition was due to the fact that the ends had not

been cut true, consequently, when joined together, the strain was not evenly distributed across the width of the belt, falling more on some points than on others and resulting in the tearing out of the fasteners.

As to Belt Dressings

If a belt does not operate properly or does not seem to grip the pulleys as it should, the average shop superintendent gives the belt a generous dose of belt dressing. It is the writer's belief that as a general thing belt dressings do little good and tend to shorten the life of the belting. In most belt dressings a certain amount of resin is used and in almost all dressings some form of graphite. While both of these compositions possess certain adhesive qualities, in time they are bound to ruin the fiber of the leather. If leather belting is properly curried, it seldom becomes hard or dry, unless it is working under conditions where it is impractical to install a leather belt. In practical experience, it has been found advisable, under such conditions, to use as a belt dressing tallow mixed with a certain amount of castor oil. The tallow softens the fibers of the leather and the castor oil restores to a large extent the adhesive qualities in the belt. But even this most harmless type of dressing should be used sparingly, or the result will be a stretching of the leather. Where trouble is experienced through slippage of the belt, a few drops of castor oil on the pulley where the slipping occurs will be found to give good results. The oil will not injure the leather to the extent that most dressings will. Most all the slippage of belts is due to the fact that frictional heat causes the grain or pulley side of the belting to become dry. Castor oil tends to soften the grain and reduce slippage. Belt dressings, if not used very sparingly, in places where there is a certain amount of dust in the air, will invariably clot on the belt and cause it to run unevenly.

General Service Conditions

The problem of selecting a proper type of belting for different classes of work is one that requires careful study and much experimenting on the part of those who operate different classes of machinery. Considerable money could be saved in belt replacements if the type of belting best adapted for the place were used. The writer knows of many instances where for years leather belting had been used on some particularly difficult drive, where it had an average life of only from two to three months. After allowing this condition to continue for years, the factory superintendent would finally instal some other type of belting which would be found to last much longer than the leather belting. This condition works both ways. Most of the largest belt manufacturers have experimented with different types of belting on different classes of machinery and are able to give authoritative recommendations as to which type of belting will prove most economical for each machine. Such recommendations should receive careful attention with a view to economies. The problem of properly belting machinery is a large one. New types of belting, new methods of fastening and new types of belt dressings are being introduced almost every day. While the proposition of belt transmission is an old one, there is still much room for improvement and need for closer attention on the part of those who use belts.

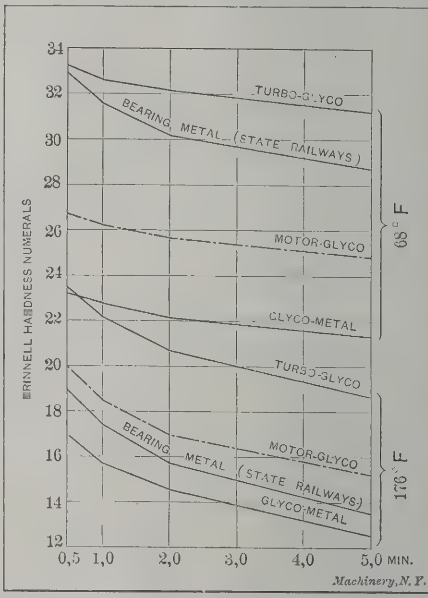
* * *

A NEW METHOD OF GALVANIZING

A new method of galvanizing has recently been patented by George L. Paterson, Thomas L. Mornes and Carl H. Zieme of New Castle, Pennsylvania. The iron or steel to be galvanized is first coated with a paste composed of 88 parts of zinc flue dust, 2 parts of lamp black and 10 parts of clay. These ingredients are mixed with water and applied to the cleaned surface. The material is then placed in a furnace and heated to a temperature of from 600 to 1,000 degrees F. The heating is continued from one-half to four hours, when the article is removed from the furnace and allowed to cool in a place free from oxidizing influences. The paste, now dried, is easily removed, but the surface of the iron or steel is coated with zinc. The inventors claim that the coating thus produced is superior to that obtained by "sherardizing," and that much less zinc dust is used. From a sanitary point of view, the process is also commendable, as the operators are not subjected to the influences of the dry zinc dust.

THE TIME ELEMENT IN HARDNESS TESTS BY THE BRINELL SYSTEM*

A diagram indicating the effect of the time element in hardness tests made by the Brinell method is given in the September 25, 1909, issue of the *Zeitschrift des Vereines deutscher Ingenieure*, and is reproduced in the accompanying engraving. The tests were made by the German Glico Metal Co. On the lower scale in the diagram is given the time, in minutes, during which the pressure on the metal was permitted to act, while the scale on the left-hand side gives the hardness numerals according to the Brinell hardness scale. It will be noted that the longer the pressure was permitted to act, the greater was the impression made on the metal, so that a lower hardness numeral resulted. Two sets of curves are shown, one with the metal heated to 176 degrees F., and one with the metal at 68 degrees F. It is interesting to note that the curves in each set are almost parallel, except in one case, thus indicating that for *comparative* purposes the Brinell test is accurate no matter what the length of duration of pressure, provided, of course, that the various samples tested are all subjected to pressure for the same length of time. It is also interesting to note the difference in the hardness of the metal brought about by the change of temperature. It will be seen that at the higher temperature its hardness numeral is not only less than at the lower temperature, as, of course, would be expected, but when the pressure on the metal is permitted to remain for a longer time, the metal apparently gives away much easier to continuous pressure when heated than when at a lower temperature. Tests of this kind should be of great value in determining the relative value of bearing metals which for long periods are to be subjected to heavy pressures under increasing temperatures. A new factor in hardness testing is also introduced, which the Brinell method is particularly adapted to measure, *viz.*, the power of resistance to *continuous* pressure of various metals, a factor which may be found to vary considerably for different materials.



Curves showing the Variation in Results obtained in Hardness Tests of Varying Duration

* * *

An apparatus was exhibited by Mr. S. H. Schneider at the meeting of the British Association for the Advancement of Science at Winnipeg, which seems to claim the distinction of being a new *perpetuum mobile*. The apparatus, which was not satisfactorily described, consists of a collapsible air-tight box which, when closed, sinks in water by its own weight. On reaching the bottom it is expanded by a magnet, when, being lighter than the water displaced, it rises to the surface where it again folds up and sinks. The inventor states that a full-sized generator weighing 600,000 pounds and displacing 10,000 cubic feet of water would generate 50,000 horse-power at practically no cost of operation. Surely the millennium is fast approaching!

* * *

To prevent the formation of rust inside boilers, experiments have been made at the Berlin Technical Institute, Germany, to use water deprived of the air it contains by means of charcoal. Sacks of freshly prepared charcoal have been put into the water from which the boilers were fed, and the decrease of rust in the boilers fed with this water has been about twenty-five per cent.

* See MACHINERY, September, 1908: The Brinell Method of Testing the Hardness of Metals.

ASSEMBLING A 24-INCH ENGINE LATHE*

ALFRED SPANGENBERG†

While the problems encountered in assembling engine lathes are not as difficult of solution as those met with in assembling machine tools of a more complicated nature, thorough and careful consideration of the methods employed is essential in order to minimize the cost. The most important operations involved are the scraping of the bed and carriage and the lining up of the head- and tail-stock. To a large extent the cost of these operations is dependent on the accuracy of the machine work.

It is the object of the present article to discuss the methods employed in machining, and to illustrate and describe the erecting process on the bed, the principles involved in assembling the units having been fully outlined by the author in previous articles in the September and October issues of MACHINERY. For the purpose of giving a concrete example, a 24-inch engine lathe with quick-change gear device is selected, the general features of which are shown in Fig. 1.

Planing the Bed and Carriage

The practice of some makers to rough out the surfaces to be planed on the bed and carriage, and allow them to season before taking the finishing cuts is indicative of the modern tendency toward accurate machine work as a means to avoid unnecessary scraping. The seasoning process simply consists in letting the casting stand in some convenient place in such a way that it will not be subjected to any outside forces, and allowing the stresses in the casting itself to become equalized.

Next in importance to providing accurate planers on which to machine the bed and carriage, is the necessity for gages that will enable interchangeable work to be produced. The gages shown in Fig. 2 are particularly well adapted to this class of work, and are far superior to the common type having a bearing on both sides of each V. Feelers or thickness gages are used in connection with the gages illustrated, in order to measure the amount of error. The advantages this form possesses over the common type are that the V's on the casting being fitted will both be of the same width, and no difficulty is experienced in keeping the gage level, since it always lies in a horizontal plane by resting on the top of each V. At *A* and *B* are shown gages for the bed and carriage respectively; these gages are made of steel ¼ inch thick.

Assuming, for example, that the V-surface on the bed at *C* is tight to the gage, and a 0.002 inch feeler will just pass between the bed and gage at *D*, then 0.002 is the exact amount that must be planed off the surface *C*. When these two surfaces fit the gage so that no error can be detected with a 0.001 feeler, the gage is turned end for end, and the surfaces *E* and *F* are tested in the same manner. It is, of course, necessary to set the gage square with the bed and this is accomplished by trying the feelers on both sides of the gage. The same remarks apply to the carriage gage *B*. At *G* and *H* in the same engraving are shown gages in the form of cast iron blocks about 6 inches long which are used for testing the ways on bed and carriage as indicated; *I* is a sheet steel strip fastened to one end of gage *H* and this is used to test the apron seat *J*. All other measurements are tested with ordinary height blocks or caliper gages, as the case may require.

Referring now to the carriage, the sequence of operations in finish planing it is to plane the bearing for the shoe, and square up the ends, and then turn it over in the position shown in the engraving and plane the V's and other surfaces on this side. It is good practice to plane lathe carriages of this size in lots of six at a time by placing them in a "string" on the planer table. When completing the final operation, that of planing the V's, it is evident, however, that the carriages farthest away from the angle plate by which they are squared up, are particularly liable to error. With careful setting up, this error should not exceed 0.003 inch, which is easily and quickly scraped off by the assemblers.

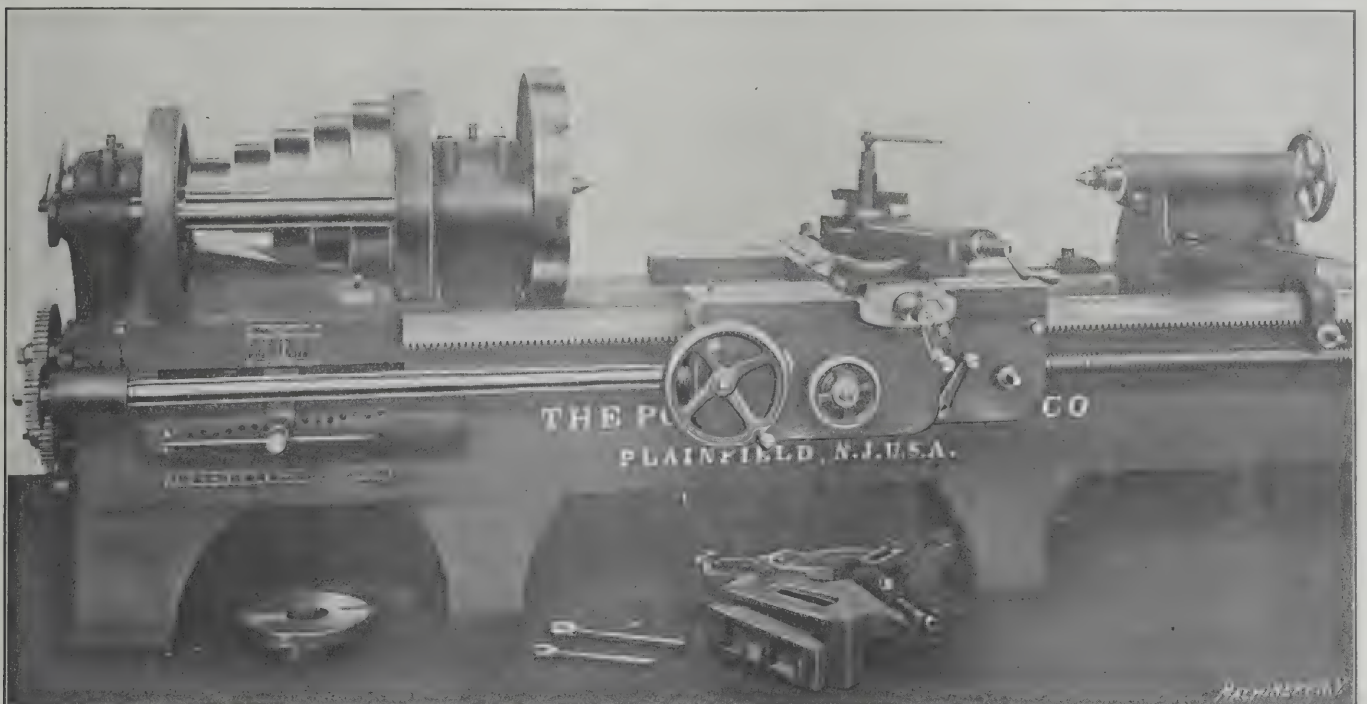


Fig. 1. Twenty-four-inch Engine Lathe with Quick-change Gear Device

Machining the Head- and Tail-stock

The methods of machining head- and tail-stocks vary greatly in different shops, and also with different sizes. Some makers first finish all the planing and then perform the boring operations and scrape in the head-stock spindle, while others leave a finishing cut to be taken on the bottom of the head- and tail-stock after the boring and scraping are completed, by setting up the castings on arbors held in V-blocks on the planer table. Both systems, or modifications of both, are frequently used in the same shop. While the first-mentioned system is the most economical in that it saves setting up the work on the planer twice, it is essential that the machining be such that very little scraping is required on the head-stock boxes; otherwise the head-stock will be thrown out of line in fitting the spindle, which necessitates replaning the head-stock and possibly the tail-stock.

In any event, it will always pay to leave 1/16-inch stock to be bored out of the bearing boxes, so that after the boxes are fitted in the head-stock it can be replaced in the boring jig and a finishing cut taken in the boxes, allowing 0.005 inch to be reamed out. Adjustable shell reamers are mounted on the boring-bar for this purpose. When this precaution is taken, and

* For additional information on this and kindred subjects, see "Assembling Machine Tool Units," in the October, 1909, issue of MACHINERY, and articles there referred to.

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the spindle is accurately ground to size, very little scraping should be necessary to make a good bearing. The object of leaving the 1/16-inch to be bored out with a cutter before reaming, is to insure that the reamer has an even cut and that sufficient stock is left for reaming.

Boring and Drilling the Bed

When all the planing is finished on the bed, it is next sent to the drilling department where the first operation consists in boring the shaft holes for the tumbler mechanism shown in Fig. 3. This operation is performed on a horizontal drilling and boring machine with the aid of a jig which also locates the sweep clamping bolt hole. The shafts *A* and *B* run in long cast-iron bushings that are a light drive fit in the bed, and to provide for standardization and enable the bushings to be finished in large quantities, the holes in the bed are reamed to gage, adjustable shell reamers being mounted in the boring bar for this purpose. The hole for stud *C* is drilled and then finished with a rose reamer, after which it is hand reamed to gage. This hole and the sweep clamping bolt hole are the only ones that require facing, the method of taking the measurements being apparent from Fig. 4; *A* is a sheet-iron templet having an outline indicated by the heavy line; the opening at *B* locates the surface to which the stud boss is faced, while at *C* is shown whether there is sufficient clearance cored out for a feed gear. The templet is located sideways by the spline *D* which is riveted to the templet and fits the keyway in the bed; and endwise by being brought flush with the end of the bed. When in this position lines are scribed at *B* and *C*, after which the templet is removed and the hole counterbored to the line; *C* is chipped out later on if necessary.

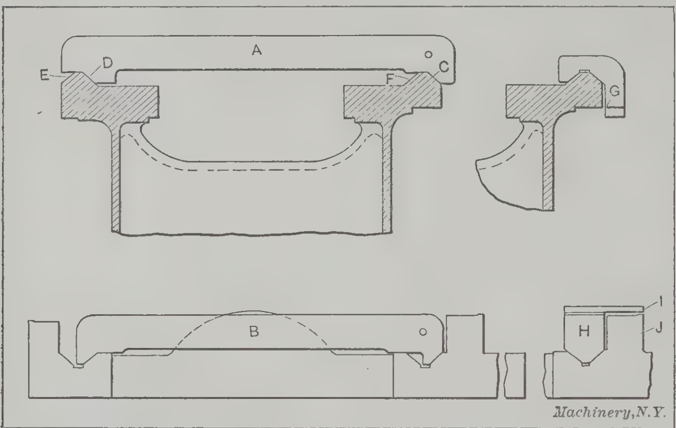


Fig. 2. Gages for Testing the Planing of Lathe Bed and Carriage

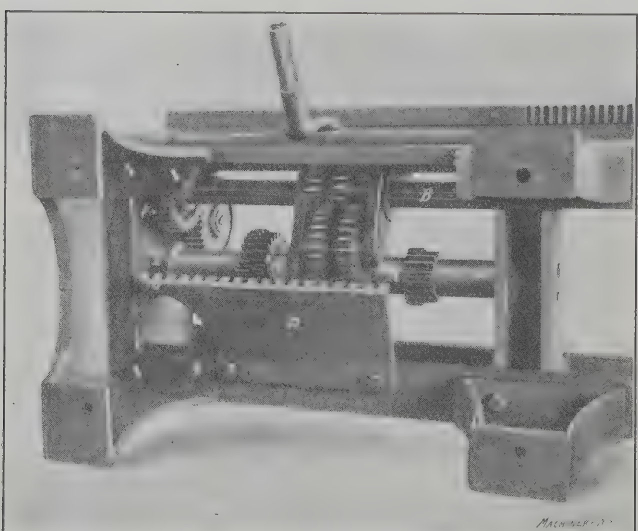


Fig. 3. Quick-change Gear Mechanism of Lathe shown in Fig. 1

To locate the surface *E* for the sweep clamping bolt hole, the gage *F* is used, its construction being clearly shown in Fig. 4. All lateral measurements on the bed are taken from the surface *B*. Facing surface *E* completes the operations for this setting, and the bed is then moved around for drilling and tapping the lead-screw box bolt holes.

In Fig. 5, *A* and *B* are jigs for drilling the front and rear lead-screw box seats, respectively. As will be seen, both jigs are located from the flat surface on top of the bed, the rear jig clearing the front V. Jig *A* is located endwise by seating against the hub *C*; the wooden pole *D* is used to set jig *B*. This pole has lines cut on one side, giving the settings for various lengths of beds up to 16 feet, so that the distance between the boxes, when bolted on, will be correct for the lead-screw. For longer beds, especially those in two sections, jig *B* is set from the rear end of the bed, and after the boxes are bolted on, the measurement is taken for the length to cut the lead-screw; it is not practicable to set the rear box or cut the lead-screw in the same way in this case as in the previous one, due to the error that is likely to occur in the length of the bed. This completes the work at the horizontal drill, and the bed is now moved to a radial drill, where the holes for the rack are next drilled. Special eccentric clamps are used for holding the rack in place, one of which is seen resting on top of the bed in Fig. 7. The advantages of this clamp over the common C-form are that it does not mar the work, no copper packing is needed, the clamping and loosening is quickly accomplished, and there is no danger of shifting the rack when clamping it.

When holes for the rack are all drilled, including the pin holes, the drill-hand taps and enters one screw in each rack section, so as to keep the rack in place after the clamps are removed, and until the bed reaches the assemblers. This avoids tying up the radial drill while the rack is being fastened on the bed, which is the practice in some shops.

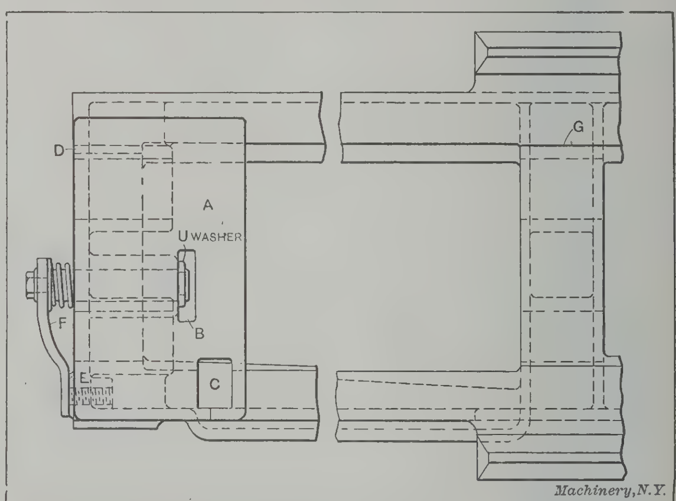


Fig. 4. Templet and Gage used when boring the Bed, shown in Position

On top of the bed in Fig. 7 are shown two fixtures *A* and *B*, respectively, which are used to locate the tumbler locking bar *D*, Fig. 3. Fixture *A* is also used to set the bushings *E* and *F*, Fig. 3, by inserting the stud in the fixture in place of the stud *C*, and bringing the bushings (which are straight) up against the hubs shown on the fixture. Now, with fixture *B* in position in the tumbler shaft hole, the locking bar is set so that its first notch *G*, Fig. 3, fits over the projection *C* of fixture *A*, Fig. 7. The plates *D* and *E* on fixture *B* are then moved so as to enter slots near the ends of the locking bar, after which the locking bar is set so that its slots bottom in the fixture plates. In this position the bar is marked off, and after drilling the two bolt holes, which have 1/16-inch clearance, it is again placed in position and clamped by its bolts. It is then shifted so as to bring it in the correct relation to the fixtures, and then the pin holes are drilled. With the bushings *E* and *F* (Fig. 3) located as previously mentioned, their set-screw holes are now drilled.

The legs are set and marked off on the bed with the aid of a wooden pole having lines scribed on it representing the center line of each inner leg. After these holes are drilled and tapped and the legs bolted on, the bed is next turned right side up for drilling the head-stock clamping bolt holes. The jig for drilling these holes is located on the bed by the keyway *D*, surface *G*, and hub *B*, Fig. 4, so that when the head-stock, which also was drilled by this jig, is bolted on, the feed gear on the spindle will line up with the intermediate feed

gear in the bed, and the head-stock casting will match the end of the bed. This completes the drilling, and the bed is next sent to the assemblers, where the actual work of assembling proper begins.

Scraping the Carriage and Assembling the Tumbler Mechanism

It is the general practice to keep the head-stocks, tail-stocks, carriages, tumbler members, etc., in stock, completely assembled, these units being identical for any length of bed. This method will be considered here, it being assumed that the units already have been brought to the assemblers. Two men usually are employed in assembling a lathe of this size, since a larger number cannot advantageously be used. Two men should be able to assemble such a lathe in 40 hours, total time. The operations of scraping on the carriage and assembling the tumbler mechanism are, of course, carried on simultaneously, one man working on each job; but for the purpose of description, each operation will be considered separately.

The preliminary operations on the bed consist of rough scraping the V's and inside bearing for the tailstock, fastening on the rack, and polishing the sides and top. When fastening on the rack, and polishing the sides, the bed is turned over for convenience of the workmen. The rack, which was temporarily fastened on by the drill-hand, is now removed and all the holes tapped, after which it is screwed fast, the pin holes reamed, and the pins driven in. A carpenter's brace is used for the taps and reamer. As the rack already has been polished on a disk grinder, it is only necessary to rub it with emery cloth to obtain a good finish. The bed is now turned right side up and carefully leveled, using iron wedges. During these preliminary operations the painting and any necessary chipping is done.

For scraping the carriage to fit the bed a special lifting device is used to facilitate turning the carriage over. This device was described by the author in the February issue of MACHINERY. When the carriage is being pulled along the bed for the purpose of finding the bearing, the lifter bolts are slackened off so as to prevent any danger of springing the carriage.

Fig. 6 clearly indicates the method of squaring the carriage with the bed. As will be seen, the sweep bar A is held in firm contact with the angle and bottom bearing of the carriage by means of two flat steel springs B, bent to the shape shown.

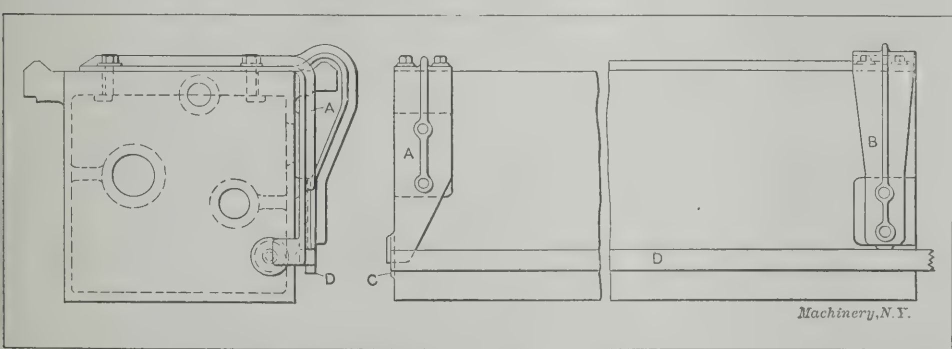


Fig. 5. Jigs used for Drilling Lead-screw Box Bolt Holes in the Bed

Brass shoes C, riveted to these springs, prevent the latter from cutting or scratching the bar. The function of coiled spring D is to hold the sweep bar collar E in close contact with the end of the carriage. With this device, the sweep is easily and quickly applied or removed, more precise measurements are obtained than by having an operator hold it, as is the usual practice; and besides, only one man is required to perform the operation of testing. In operation, micrometer point F is set to one position as shown, using a piece of cigarette paper as a "feeler"; then the sweep is rotated to the opposite side and a measurement taken as before. The carriage is scraped so as to turn the face-plate about 0.001 inch concave.

Very little scraping is necessary on the bed, merely enough to smooth the V's and break up the bearing, the tool marks being visible after the scraping is completed. When this work is accomplished, the carriage gibs are fitted, the apron is bolted in place, and the cross-feed screw, shoe, etc., are placed in position. Next, the tail-stock cricket is placed on the bed and its packing fitted, after which it is pulled the entire length of the bed to determine if the latter is straight. After any high spots on the bed are scraped off, the tail-stock traverse bracket is bolted onto the cricket, and then the tail-stock and its shoes are placed in position.

Referring again to Fig. 3, the tumbler mechanism is assembled in the bed as shown in the illustration, the operation being so simple that no explanation is necessary. Holes in the bed for the oil pipes (not shown) are drilled by means of a pneumatic drill, this being done, of course, preceding the assembling operation. The slot in the interlocking plate H is now marked off, the plate removed, and the slot cut. The position of this slot is determined by having the tumbler gears in a central position between the largest change gears. With the interlocking plate again screwed onto the tumbler, the thirty-four holes in the bed for the tumbler locking pin are now ready to be drilled.

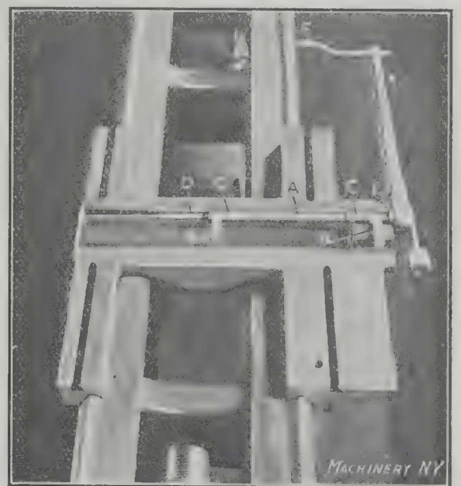


Fig. 6. Top View of Carriage, showing Method of Squaring the Carriage with the Bed. Springs B and D hold the Sweep in Position, enabling One Man to make the Test

Drilling these holes is the most interesting operation on this part of the lathe, the manner of accomplishing it being immediately apparent from Fig. 8, which shows the tools used, some of them being seen on top of the bed. The method of holding the tumbler in engagement with the various change gears while drilling the holes in the bed is clearly shown in Fig. 9. Paper, to the thickness of about 0.005 inch, is placed between the teeth of the engaging gears before they are brought into mesh, and when the jack screw A is tightened sufficiently to hold the tumbler rigidly in place, the gears are in proper mesh. The holes are first drilled with a special drill that fits the locking pin hole in the tumbler and has flutes milled only a short distance up from the point, so as to avoid cutting the hole in the tumbler. Fig. 8 shows this drill in position in the air drill. For finishing the holes, a special rose reamer, shown at B, is used in the same manner.

The tools are fed into the work by means of the bar C, which is pointed on one end so that it can be driven into the floor to prevent slipping. The operator presses his shoulder against the upper end of the bar, holds the throttle of the air drill with the left hand and pulls on the bed with the right hand. Each hole is drilled in succession, alternating between the top and bottom rows. The record for drilling and reaming these thirty-four holes, including the time required to set the tumbler, is 50 minutes. In setting the tumbler for drilling, its lateral movement for the various positions is controlled by the interlocking plate engaging the respective slots in the locking bar. (See Fig. 9.)

To mark off the groove which is seen between the two rows of holes in Fig. 1, a special scriber is used that fits the tumbler locking-pin hole, the tumbler being held in a neutral position by the locking bar. Two circles are scribed, one at each end of the groove to be cut, and then a straightedge is used in scribing lines connecting the two, the lines acting as a guide when chipping the groove with an air hammer. Inserting the handle, chipping the groove, and fastening on the number and index plates completes the operation on the tumbler mechanism.

Lining up the Head-stock and Tail-stock

The bed is now ready to receive the head-stock and while this is being fitted on by one of the assemblers, the other is working on the lead-screw, lead-screw boxes, and change gear sweep. As the head- and tail-stock were tested for alignment before being sent to the store-room, it is now only necessary to line up the head-stock on the bed and fit the taper dowel pins.

The method of testing these parts is interesting, inasmuch as the test arbor used is somewhat out of the ordinary. A jig is used that represents the head-end section of a 24-inch lathe bed. The jig and whole outfit of fixtures used, together with a head- and tail-stock in position for testing, is shown in Fig. 10. As will be seen, the test bar is square at *A*, near each end, the object being to use the indicator on a flat surface when testing the spindle for parallelism with the V's, and on a cylindrical surface when testing the spindle taper hole for concentricity. The two squares are integral with a sleeve that can be turned independently of the bar, and in this way one plane surface can be set at a mean between the "high" and "low" point on the bar. This adjustment is obviously necessary, since the bar is particularly liable to run out at its free end, due to a number of conflicting elements, the error in any one of which may be infinitesimal. When using the plane surfaces, one of these is always trued up with the square *B*, as shown in the engraving.

The reason for providing a plane surface on which to indicate is this: Suppose, for example, that we are testing the spindle for alignment sideways, and further that the axis of the spindle actually is parallel sideways with the bed, but

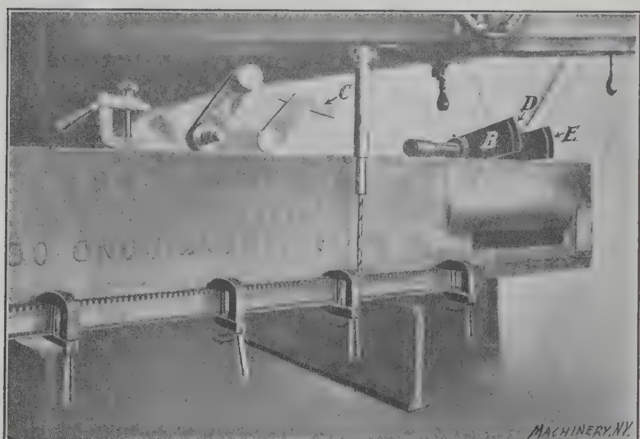


Fig. 7. Special Clamps for Holding Rack in Position when Drilling, and Fixtures used for Locating Tumbler Locking Plate

that the axis does not lie in a horizontal plane, it being high on the front end, say 0.005 inch in the length of the test bar. Then in indicating on the older type of bar with cylindrical collars, the line of motion of the indicator point in traveling from one collar to the other is not parallel with the axis of the test bar and therefore the readings are false. Now, with the form of bar having plane surfaces, assuming the conditions to be the same as regards the alignment of the spindle, the reading will show that the alignment is perfect sideways, because the indicator point is moving on a plane surface.

Referring again to Fig. 10, the fixture *C* is guided on the V tracks of the bed and is constructed so that it is adjustable for holding a Starret indicator *D* either on the side or top of the bar as the case may require. Having explained the use of the tools and fixtures, the method of "lining up" the head-stock and tail-stock, both with reference to the V's and to each other, is to place them on the bed and approximately set the head-stock true sideways by inserting keys in the keyways planed in the head-stock and bed for this purpose.

With the clamping bolts tightened lightly (the bolts have 1/16-inch clearance), the head-stock spindle taper hole is first tested for concentricity by indicating on the cylindrical surface *E* while slowly rotating the spindle. Then with the squares *A* set as previously explained, the head-stock is moved around by knocking it with a babbitt hammer until the reading on both surfaces is the same. The bar is then moved over into the tail-stock spindle hole, and after the set-over screw *F* is adjusted so as to bring this spindle in line with that in the head-stock (the reading being the same as before) the tail-stock spindle is tested for alignment sideways. Now the indicator is set on top of the bar, with the latter turned so as to use the same surface, and then the tail-stock spindle is tested for alignment in a horizontal plane, after which the bar is again set into the head-stock spindle hole and that spindle tested both with reference to the V's and to the tail-stock spindle. It is understood, of course, that if any errors are discovered which exceed the allowable limits of variation, the part at fault is either filed and scraped to bring it true, or machined, if the circumstances warrant.

Turning again to the lathe bed, we will assume that the head-stock is lined up as just described, and the clamping

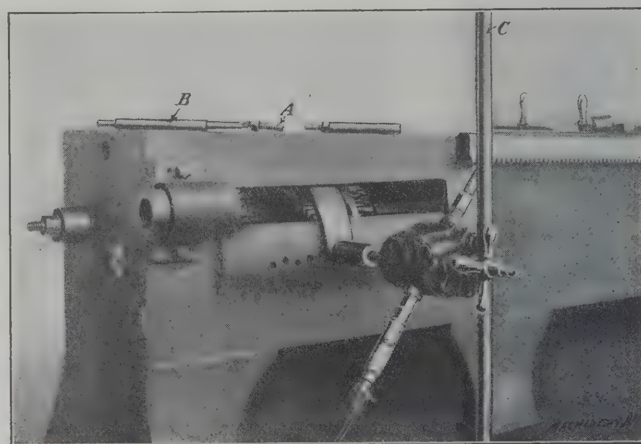


Fig. 8. Method of Drilling and Reaming the Holes in the Lathe Bed for the Tumbler Locking Pins

bolts are tightened down hard. The taper dowel pin holes are then drilled, reamed, and the pins driven in, care being exercised to see that the pins are a good fit. Next the face-plate is screwed on, ready to be turned off.

Lining up the Lead-screw Boxes

As was previously stated, work has been progressing on the lead-screw boxes and other minor details. For the purpose of lining up the boxes and also to test the alignment of the lead-screw bearings in the apron, a short arbor is used that represents the lead-screw. First the apron is tested, and then the lead-screw boxes are bolted onto the bed and lined up with the apron. Sometimes it is necessary to file the apron seats or adjust the boxes to bring them into proper alignment; but with careful planing and thorough inspection of the parts, this should not be required. Two special gages are used to

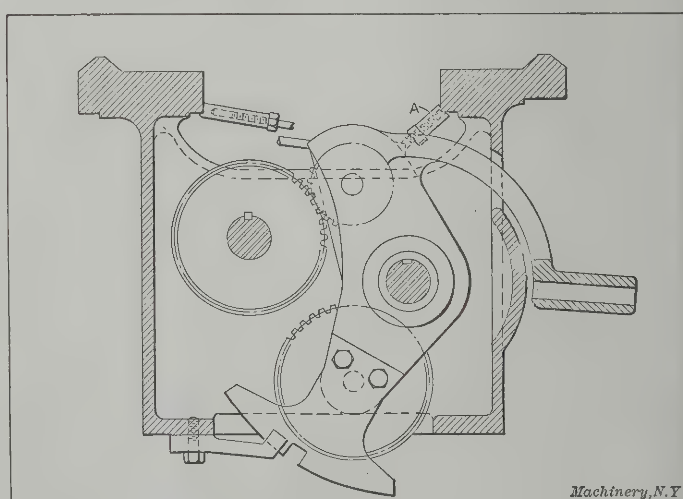


Fig. 9. Method of Holding Tumbler when Drilling and Reaming the Locking Pin Holes by the Method shown in Fig. 8

facilitate the aligning; one gage reaches down from the flat track on top of the bed for horizontal measurements, while another is held against the side of the bed just below the V to test sideways. Both gages are provided with micrometer points to enable the accurate measurement of error.

Referring to Fig. 1, the head-end lead-screw box is set longitudinally when the change gear sweep is in place, so as to line the box with reference to the sweep bearing on the end of the bed. When properly set, the boxes are drilled and reamed for the taper dowel pins; then the lead-screw is put

in place, its checknuts screwed on, and the gears on the sweep brought into proper mesh.

The Finishing Operations and Inspection

With the cone belted up to a countershaft or other source of power, the bearings are thoroughly oiled, and the lathe is run idle for a while preparatory to turning off the faceplate. The V's on the bed and bearings on top of the carriage are now spotted with a scraper, while all other finished surfaces receive their final polishing. The centers and their respective holes in the spindles were fitted to male and female gages during the machining process, so that now it is only necessary to place the centers in position. Clamping on the center-rest is the final assembling operation.

All machines are more or less defective, as it is practically impossible to make anything absolutely perfect. Knowing this, the builder establishes a limit within which the error will not materially affect the working of the machine, and furnishes the inspector with a list of allowable limits.

The inspection is carried on as the work proceeds, so that no part is neglected, and no defective material or faulty workmanship is allowed to pass. Gearing of all kinds is inspected and tested for alignment and smoothness of operation. The fits of all wearing surfaces are tested, as well as the fit of the various screws and binding and clamping fixtures. All information obtained from the inspection is entered on a printed form. Each machine is given a serial number, and the reports are filed in the office, so that in case of any trouble arising or any repairs being required for a given lathe, an exact record of its condition when it left the shop is available.

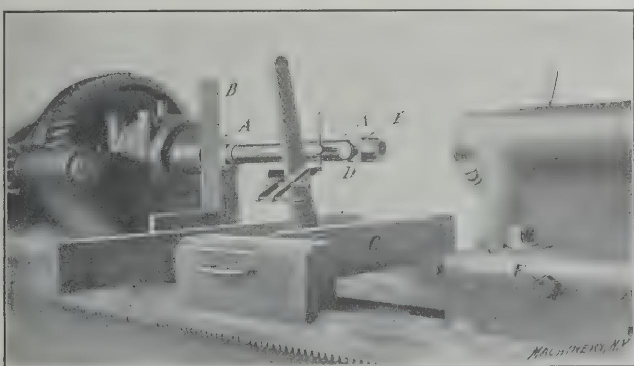


Fig. 10. Special Form of Test Bar for Aligning Head- and Tail-stock. Plane Surfaces are used for Testing Parallelism, and Cylindrical Surfaces for Testing Concentricity

After truing up the face-plate, it is tested by means of a straight-edge and cigarette paper, this kind of paper being the best for the purpose. The spindle is tested for end motion when running, by application of the Starrett indicator to the face of the spindle nose. To prove the alignment of the head spindle with the shears of the lathe and the alignment of the taper hole with the spindle, under actual working conditions, a steel test bar is provided which fits the taper hole and projects 18 inches from the spindle. This bar carries three cast-iron collars, placed one at each end and one in the middle, from which all measurements are taken. A light cut is taken across these collars with a keen diamond-point tool, and the collars are then measured with a micrometer. As it is desirable when boring a hole, to have the taper, if any, large toward the front end, the front end of the head-stock was purposely set slightly toward the rear of the bed so that the outer collar should be found 0.0005 inch larger than the collar next the spindle. The alignment of the spindle in the vertical plane is again tested by attaching the indicator to the tool-post and traversing the carriage along its ways with the contact point of the indicator pressing against the top surface of the collars.

In testing the alignment of the taper hole with the spindle itself, after the collars have been turned off, the test bar is removed, turned half way round and replaced in the spindle; the indicator is then put in the tool-post in place of the turning tool, and with the contact point on the center line the indicator is traversed past the collars, the variation in readings showing twice the error in the alignment of the taper. The alignment of the tail-stock spindle is now tested, the method being the same as in the previous instance.

APPROXIMATE HORSE-POWER FORMULAS FOR GASOLINE ENGINES

In the September 3, 1909, issue of *Industritidningen Norden*, Mr. E. Hubendick reviews the various approximate formulas which have been adopted or proposed by a number of societies and individuals for the horse-power of gasoline engines. In these formulas

D = diameter of cylinder,
N = number of cylinders,
S = length of stroke,
n = number of revolutions per minute.

The French Automobile Club's formula is:

H. P. $= 0.07\ D^2N$, when the diameter is given in centimeters,
H. P. $= 0.45\ D^2N$, when the diameter is given in inches.

In this formula the mean pressure has been assumed to be 5.3 kilograms per square centimeter (75 pounds per square inch), and the piston speed 5 meters (16 feet 5 inches) per second.

The Royal Automobile Club's (British) formula is:

H. P. $= 0.0625\ D^2N$, when the diameter is in centimeters.
H. P. $= 0.405\ D^2N$, when the diameter is given in inches.

Mr. Arnon's formula is:

H. P. $= 0.0061\ D^3N$, when the diameter is in centimeters.
H. P. $= 0.1\ D^3N$, when the diameter is given in inches.

Mr. Faroux's formula is:

H. P. $= 0.0074\ D^{2.4}\ S^{0.6}$, when the diameter is in centimeters.
H. P. $= 0.121\ D^{2.4}\ S^{0.6}$, when the diameter is given in inches.

Another French formula is as follows:

H. P. $= 0.02562\ D^{2.4}\ N$, when the diameter is in centimeters,
H. P. $= 0.24\ D^{2.4}\ N$, when the diameter is given in inches.

Mr. T. Thornycroft's formula is:

H. P. $= \dfrac{D^2\ S^{0.75}\ N}{35{,}000}$, when the diameter is given in centimeters,

H. P. $= \dfrac{D^2\ S^{0.75}\ N}{2{,}700}$, when the diameter is given in inches.

Prof. H. L. Callender's formula is:

H. P. $= 0.0875D\ (D - 2.5)\ N$, when the diameter is given in centimeters,
H. P. $= 0.565D\ (D - 1)\ N$, when the diameter is given in inches.

In this latter formula the mean pressure is assumed to vary in the same proportion as $\left(1 - \dfrac{2.5}{D}\right)$ if the diameter is given in centimeters, and $\left(1 - \dfrac{1}{D}\right)$ if the diameter is given in inches.

The Royal Automobile Club's (Swedish) formula is:

H. P. $= \dfrac{D^2SnN}{250{,}000}$, when the diameter is given in centimeters,

H. P. $= \dfrac{D^2SnN}{15{,}240}$, when the diameter is given in inches.

In this connection the formula of the Association of Licensed Automobile Manufacturers, which has previously been published in MACHINERY, should be included:

H. P. $= \dfrac{D^2N}{2.5}$, when the diameter is given in inches.

H. P. $= 0.062\ D^2N$, when the diameter is given in centimeters.

The horse-power of automobile engines, based on this last formula, for various diameters of cylinders, was tabulated in the Data Sheet Supplement accompanying the October, 1909, issue of MACHINERY.

Some of the formulas proposed, with fractional exponents, are more cumbersome to use than would be the exact horse-power formula, and are of very doubtful value for their purpose. It is difficult to understand why one should be given an approximate formula at all, unless the form of that formula be such that it greatly facilitates computations, as compared with the exact formula. In this respect the A. L. A. M. formula is one of the best of those given above.

NORWEGIAN LATHE OF MODERN DESIGN*†

The accompanying half-tone, Fig. 1, illustrates a 20-inch engine lathe embodying some new and interesting features, including a special all-gear head-stock, which has recently been brought out by Brödrene Sundt, Christiania, Norway, one of the most prominent of the Norwegian machine tool building firms.

The special feature of this lathe is the interesting and original design of the gearing in the head-stock. As will be seen from the half-tone illustration, the machine is of the single-pulley all-gear head type; a section through the head, indicating the arrangement of the gearing, is shown in the line engraving in Fig. 2. Through an interesting arrangement of the driving mechanism, the number of gears and shafts in the head-stock is reduced to a minimum, so that only nine gears in all are used to obtain eight different speeds.

Referring to Fig. 2, the gear *A* runs loose on the spindle *K*, while gear *B* is keyed to the spindle and is capable of sliding back and forth, so that it may be either in engagement with gear *C* on the intermediate shaft *L*, or engaged by clutch teeth on its end with similar clutch teeth on gear *A*. Gear *C* is keyed to the intermediate shaft *L* and gear *D* is made in one piece with this shaft. Gear *E* on shaft *M* meshes with gear *C*. It is keyed to its shaft, and is capable of sliding out of engagement with *C*. The rawhide gear *F*, also keyed to shaft *M*, meshes with gear *G*, which runs loose on a bushing on the main driving shaft *N*. Finally, gear *H* is also keyed to shaft *M* and meshes with gear *I* on the main driving shaft. This latter gear is keyed to its shaft, but is capable of sliding so that it may either mesh with gear *H*, or be brought into engagement by means of the clutch teeth on its end with corresponding clutch teeth on gear *G*.

The different speeds are obtained by the operation of the three handles or clutch levers shown in Fig. 1, two in the front of the head-stock and one on the top. One of the handles, which provides the sliding motion for gear *E*, as indicated in Fig. 2, operates also, simultaneously, by means of the rack *P*, the sleeve *O* keyed to shaft *L*, on the end of which clutch teeth are provided, meshing with similar teeth on the projecting hub of gear *G*. Another of the levers operates gear *I*, and the third lever gear *B*.

The eight spindle speeds are obtainable by the following gear combinations:

1st speed—Through gears *I*, *H*, *E*, *C*, *D* and *A*.
2nd speed—Through gears *G*, *F*, *E*, *C*, *D* and *A*.
3rd speed—Through gears *I*, *H*, *F*, *G*, *D* and *A*.
4th speed—Through gears *D* and *A* directly.
5th speed—Through gears *I*, *H*, *E*, *C* and *B*.
6th speed—Through gears *G*, *F*, *E*, *C* and *B*.
7th speed—Through gears *I*, *H*, *F*, *G*, *C* and *B*.
8th speed—Through gears *C* and *B* directly.

These speeds are doubled by means of a two-speed countershaft running, respectively, at 200 and 260 revolutions per minute. The sixteen spindle speeds thus obtainable by means of the head gearing and the two-speed countershaft are as follows: 9, 12, 15.5, 20, 24, 30, 38, 50, 55, 70, 90, 115, 135, 175, 225 and 290 revolutions per minute.

There is no clearance between the clutch teeth on the various gears. They are milled with an angle of 7 degrees on the sides and can be thrown in mesh without difficulty, under any conditions. When gear *B* occupies its medium or neutral position the spindle can easily be rotated by hand. The driving pulley is provided with a special friction which can be instantly released by operating the friction clutch lever con-

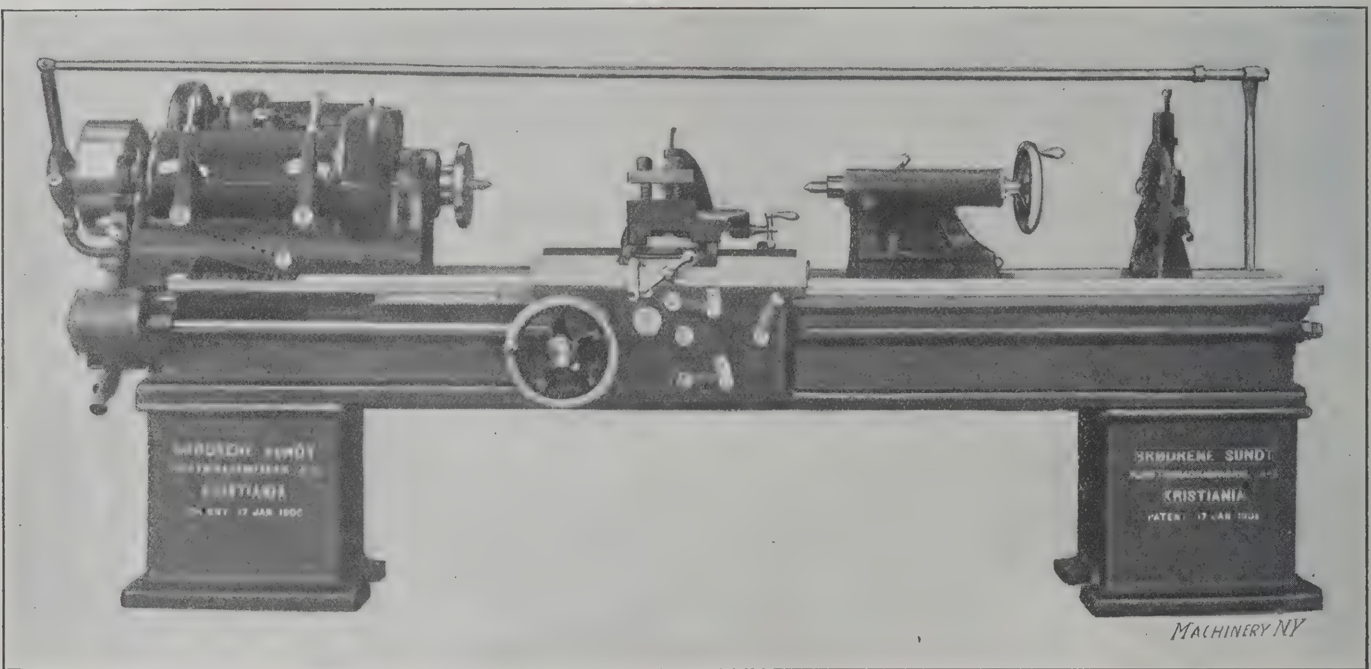


Fig. 1. Twenty-inch Lathe built by Brödrene Sundt, Christiania, Norway

* The following articles dealing with machine tools of European design have previously been published in MACHINERY: Some Notes From an English Shop, September, 1897; English Amateur Tools (Foot Power Milling Machine), June, 1902; Heavy German Milling Machine, June, 1903; Koehler's Profile Lathe, June, 1904; A Large Vertical Planer, June, 1904; Some English Lathes, September, 1904; German Lathe Carriage for Screw Cutting, October, 1904; The De Fries Precision Lathe, November, 1904; An English High-Speed Planer, July, 1905; A Pendulating Electric Drill, September, 1905; Portable Tools From Europe, November, 1906; A Vertical Miller and a Turret Lathe of English Design, March, 1907; Recent Development of British Machine Tool Industry, July, 1907; Some British Machine Tools, November, 1907; Notes From the Olympia Exhibition, December, 1907; Advanced Designs of German Drilling Machines, June, 1908; A Large Planer of English Design, August, 1908; Modern German Milling Machines, August, 1908; Large Horizontal Boring and Turning Mill, August, 1908; British Machine Tools at the Franco-British Exhibition, September, 1908, engineering edition; Herbert Automatic Turret Lathe, with Self-Selecting Feeds, November, 1908; Germaan Design of Vertical Spindle Presses, December, 1908; German Designs of Internal Grinding Machines, January, 1909; Societe Francaise de Machines-Outils Single-Pulley-Drive Lathe, March, 1909, engineering edition; Modern Swedish Machine Tools, March, 1909, engineering edition. See also, for descriptions of European gear cutting machines, a series of articles entitled Gear Cutting Machinery, January to September, 1908, and Recent Developments in Gear Cutting Machinery, February, 1909.

† The following articles describing lathes with geared heads have previously been published in MACHINERY: A New "American" Motor-driven Lathe, December, 1902; A New Motor-driven Lathe, March, 1903; The "Ideal" Engine Lathe with Motor Drive, January, 1904; New Flat Turret Lathe, May, 1904; Sixty-inch Roll Turning Lathe, October, 1904; Thirty-inch American Engine Lathe, October, 1904; Lodge & Shipley Lathe with Motor, November, 1904; American Twenty-two-inch Lathe, December, 1904; Motor-driven Lathe with Geared Head, June, 1905; The Draper Geared Head Lathe, July, 1905; Rapid Reduction Lathe, Nineteen-inch Capacity, July, 1905; Hendey-Norton Lathes, April, 1906; Pratt & Whitney Sixteen-inch Toolmakers' Lathe, March, 1907; New Design of the Lo-swing Lathe, September, 1907; The Full Swing Side Carriage Turret Lathe, December, 1907; Notes from the Olympia Exhibition, December, 1907; Motor Drive Mechanisms for the Le Blond Lathes and Milling Machines, February, 1908; Bridgeford Geared Head Lathe, March, 1908; Libby Turret Lathe, March, 1908; Springfield Motor-driven Brass Finishers' Lathe, April, 1908; Bridgeford Thirty-six-inch Geared Head Lathe, May, 1908; Hendey Single-pulley and Motor-driven Geared Head Lathes, May, 1908; Schellenbach Sixteen-inch Geared Head Lathe, June, 1908; Rahn-Carpenter Sixteen-inch Motor-driven Lathe, June, 1908; Springfield High-power Motor-driven Lathe, July, 1908; British Machine Tools at the Franco-British Exhibition, September, 1908; Lodge & Shipley Heavy Axle Lathe, January, 1909; Prentice Brothers' Sixteen-inch Shaft Turning Lathe, January, 1909; Whitcomb-Blaisdell Single-Speed-Pulley Gear-driven Lathe, January, 1909; Societe Francaise de Machine-Outils Single-Pulley-Drive Lathe, March, 1909; Modern Swedish Machine Tools, March, 1909; Lodge & Shipley Crank-Shaft Lathe, June, 1909; Lodge & Shipley Lathe With Automatic Feed Stops, July, 1909; The Lodge & Shipley "Marvel" Lathe, August, 1909; Bradford Sixteen-inch Motor-driven Engine Lathe, October, 1909; Bridgeford Bevel Gear Turning Lathe, October, 1909.

nected with the rod passing the full length of the machine, as shown in Fig. 1.

The construction of the friction drive in the pulley is briefly as follows: The friction ring *R*, Fig. 2, is made in halves enclosing the spindle driver *S*. Both halves of the ring can be made to grip the spindle driver *S* by means of the tighteners *T*, operated by the fingers *U*. Only one set of these is shown. Two helical springs hold the rings away from the driver *S* as soon as the friction is released.

The clutches in the geared head are so arranged that two different speeds can never be applied simultaneously, and therefore there is no danger of breakage to the gears due to the carelessness or ignorance of the operator. All the speeds can be changed without stopping the belt or motor.

The bed of the lathe, as seen in Fig. 1, is of deep box construction, and is ribbed on the inside at short intervals with strong cross ribs. The spindle is forged of Bessemer steel and runs in journals of phosphor bronze. As shown in Fig. 2, there is a hole clear through the spindle. The end pressure is taken up by hardened steel and phosphor-bronze washers, cased in so as to be perfectly dust-proof. All the bearings are provided with automatic lubrication, and as the spindle is free from belt pull, the accuracy of the work done on the lathe is not affected by this influence.

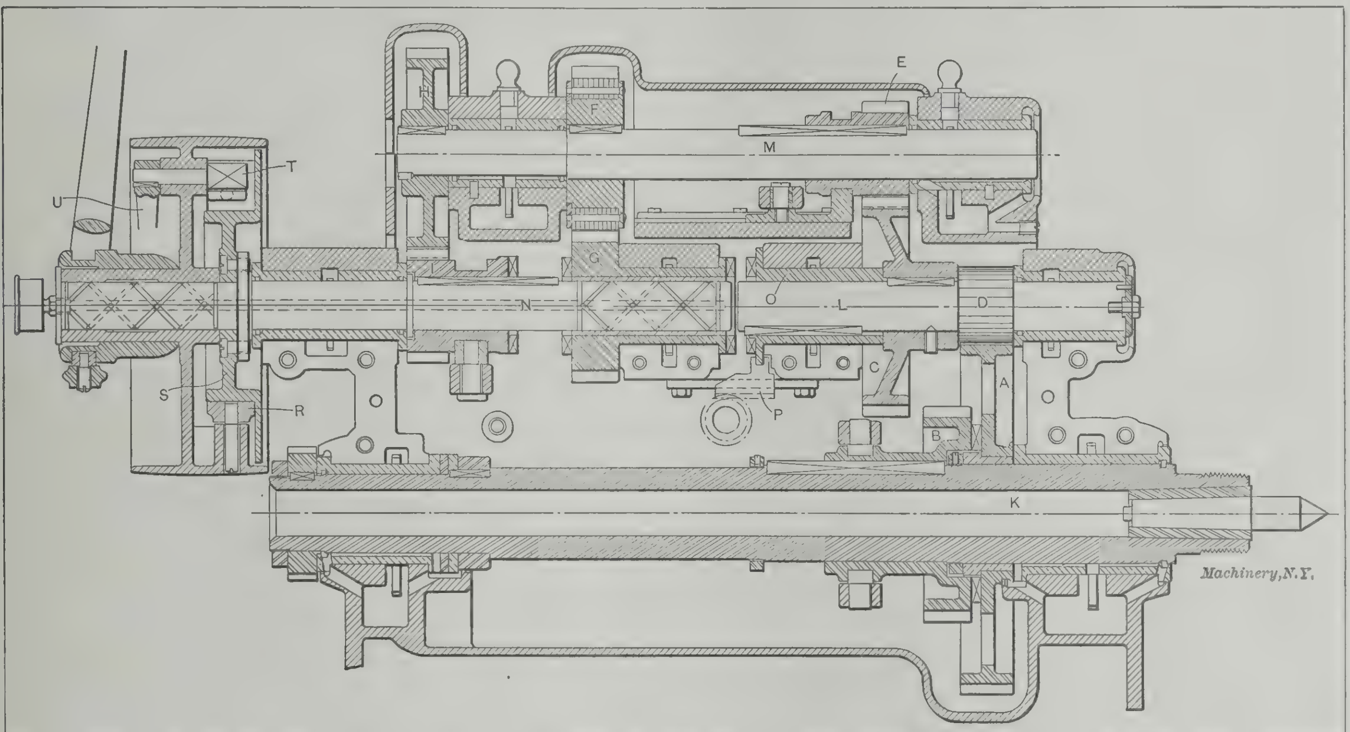


Fig. 2. Section of Head-stock, showing Geared Drive of Norwegian Lathe

The screw cutting and feed arrangement is through a feed gear box operated by two handles. Thirty-seven different pitches can be obtained for thread cutting without changing any gears or stopping the machine. The carriage is of heavy construction; the gears in the apron are cut and of steel, the same as all the gears in the head-stock. The studs for the gears are hardened and ground on the bearing ends. There is no separate feed rod, the lead-screw being splined, and the half-nuts disengaged when the lathe is not used for thread cutting, the rack-feed being used for ordinary feed of the carriage. Provision is made for preventing simultaneous engagement of the lead-screw and rack-feed, and the feeds are reversed directly from the apron. As will be seen in Fig. 1, all gears are properly protected by guards.

The general dimensions of the lathe are as follows: The swing over the bed is 20 inches, and the swing over the carriage 13¾ inches. The length of the bed is 10 feet, and the maximum distance between the centers, 5 feet 6 inches. The hole through the spindle is 1¾ inch in diameter. The machine can be either belt-driven from a countershaft, or provided with direct motor drive. A five horse-power motor is required. The approximate weight of the machine is 5,100 pounds. A 22-inch size of the same design is also made by the builders.

THE CREATION OF MACHINISTS*

Referring to the title of the paper, namely, "The Creation of Machinists," I will merely mention the matter of apprentices, because the subject of this paper is more to show how to create machinists without passing through an apprenticeship, because of the extreme shortage of machinists throughout the whole United States.

A few years back we found that we were unable to obtain boys as apprentices, for the reason that they could get better pay in other trades, such as shoe factories, tobacco factories, tanneries, dry goods and other stores, and this caused us to raise the hourly rate, which was originally 5 cents, to 8 cents. But at that time we were allowed to use boys between the ages of 14 and 16 years. Since then a law has been passed in Ohio prohibiting boys working more than eight hours when under 16 years of age; and in order to comply with this law, we discharged all boys who were under 16 years. We then found, speaking for our own company, that in order to get a sufficient supply, the rate must again be raised from 8 cents to 9 cents per hour.

Simultaneously with this difficulty of obtaining boys, came the great activity among the builders of automobiles. This occurred during the time that business was very dull in the machine tool line. When business became active once more, having the addresses of all of the machinists who were formerly employed by us, we sent to each one a letter, stating that they could return to work, and we were surprised to receive almost no responses; and we then saw that we would be obliged to go into the creation of machinists on rather a large scale. Advertising in the daily papers and in the *American Machinist* brought comparatively no results. We then decided to re-arrange our work and divide it into very much smaller items than heretofore, arranging the parts so that they could be machined with the greatest possible simplicity, and then set about inquiring for men, not machinists, and the following advertisement was put in the daily papers:

WANTED—Young men between the ages of 20 and 30 years. Fair wages and good opportunities for advancement. Men accustomed to safe making or carriage making preferred.

The first day following this advertisement we obtained twelve out of possibly thirty applicants. They were selected largely because of their former experience, and somewhat upon their personality, personal appearance and address. These twelve men were placed, one in each of twelve departments, with instructions to the foremen as to the pieces they

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.

should be taught how to produce. We found that by this method the first installment of twelve were readily assimilated, so that within one month we were ready for similar installment.

Now I will give you an idea as to how we proceeded in the matter: We arranged with a first-class machinist who has been with us a long time, in whom we have a great deal of confidence, and who possesses the art of knowing how to teach, to go from one man to another, see how he was performing his part of the work, set him right when he was wrong, and give him further explanations when an additional piece was added to the work he had already been taught. All of this involved the installment of some new tools, and in the beginning a slower production; but as these young men became better acquainted with the work, we advanced them from 15 cents to 17½ cents per hour, and some of them to 20 cents per hour, and it now appears that quite a number of them within a very short time may be advanced to 22½ cents, from that to 25 cents, and so on. As this advance takes place, they will, of course, have been taught how to do additional pieces.

All of this taxes the patience of the foremen quite considerably, and results of course in more spoiled pieces of work, but the final result of obtaining a sufficient number of men to run the establishment is brought about. There is the further advantage that men with the limited knowledge that these men must necessarily have, do not have the confidence to change into other shops so readily as the regular machinist.

There is another reason why machinists are so scarce, and that is the many fields to which they are called, and which fields do not make machinists. Let anyone call to mind how many machinists are now employed in hotels and large office buildings for running the elevators and electric light plants; how many are now taken for street railroads; besides all those who are taken into the office and drawing rooms or who are sent out on the road. Every consumer of machinists should be a producer; in the trades mentioned they are not producers, and consequently it is advisable for every machine shop, regardless of business conditions, to start more beginners than they need. The shop itself will require an increased number when the beginners graduate; some will drop out, some will be dropped, and others will be enticed into new enterprises which must have machinists ready-made. Beginners once obtained should be encouraged at every step. They should be given as little disagreeable work to do as practicable. They should be given the best work that they are capable of doing. They should be made machinists at once if their capabilities permit of it. A vacancy for even one hour in a higher place should be filled for that hour by one from a lower place. All the employes should be given all the encouragement possible that would take them into night schools, trade schools and correspondence schools. Wherever there is a serious shortage the men in your employment should be asked to invite any of their acquaintances to make application for employment in the machine shop.

To carry out the above recommendations it is necessary to make the machine shop something of a school. It is not likely that young men with a very limited knowledge of the machine making business will know just where the points of excellence are wanted, and in order to place the matter before them permanently, rather than to depend upon their foreman telling them, certain instructions, which are issued in any event to the inspectors, should be issued to each and every one of the men in the establishment, or if not, then at least they should be hung in such a position that each and every man and boy may read them.

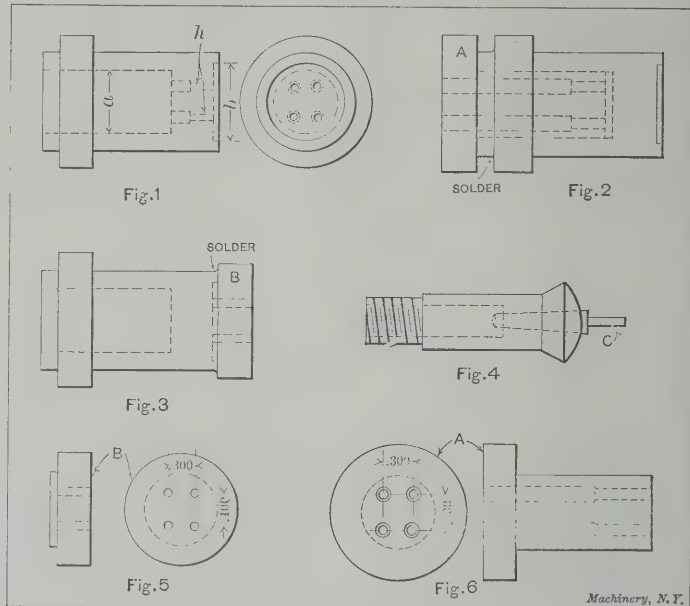
Very strict orders should be given to all foremen and superintendents to make every endeavor to retain any man who wants to leave, or anyone they are inclined to discharge. This is of the utmost importance, as otherwise it keeps a regular stream of men coming into the place and leaving it. One of the manufacturers in Detroit told me a few days ago that he was obliged to discharge and take on seven hundred and fifty men every month. It is not to be expected that we can create machinists in a short space of time without giving the method of doing it a great deal of care, and unless the man is a drunkard, or has an exceedingly bad disposition, good treatment and a sufficient amount of tact and patience will retain a great many who are otherwise discharged.

MACHINE SHOP PRACTICE*

JIG AND DIE WORK IN THE BENCH LATHE—1

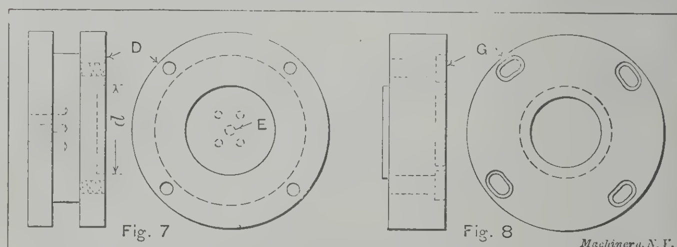
A. L. MONRAD†

In the manufacture of fine machinery, and for the finer work of the tool-room, the bench lathe is found invaluable, as the ordinary engine lathe is too large and unwieldy for this class of work. As the bench lathe is used exclusively for light precision work, it is made with great accuracy, and it is usually equipped with milling, grinding, screw-cutting and other attachments which make it suitable for a wide range of work. As an example of the kind of work for which



Figs. 1 to 6. Die and Jigs for Drilling it

the bench lathe is adapted, we have selected and will describe in detail the way in which two small jigs are made, which are to be used for drilling the holes *h* in the die shown in Fig. 1. As the inner half of each of these holes is enlarged, the drilling is done from each side of the die, the jigs *A* and *B* being inserted as shown in Figs. 2 and 3, respectively. Jig *A* is used for the larger holes, and *B* for the smaller ones. These jigs, which are shown in detail in Figs. 5 and 6, are made of brass. While they are being turned, they are held in a universal chuck screwed on the bench lathe spindle. The shoulder on jig *B* is fitted accurately to the recess *b* in the die, and the body of jig *A* is also turned to a close fit for the hole *a*. In order to bore the holes in each of these jigs in exactly the same relative positions, a steel master-plate *D*



Figs. 7 and 8. Master Plate and Attached Piece used in drilling Holes in Jigs, Figs. 5 and 6

(Fig. 7) is first made, the use of which will be explained presently. This plate should be first turned in an engine lathe; it is then strapped to the face-plate *F* of the bench lathe (Fig. 9), and both sides are faced so that they are exactly parallel. The outside of the master-plate should be set perfectly true by the use of a test indicator, after which a central hole *E* is bored and reamed to fit a plug gage 0.050 inch in diameter. The master-plate is then removed, and the four outer holes shown in the end view are laid out from the center hole to the dimensions given in Figs. 5 and 6. The centers of these holes are next drilled and tapped for 1/32-inch screws, which are to be used for holding indicator buttons in place. These buttons are small cylindrical pieces which are

* With Shop Operation Sheet Supplement.

† Address: 58 Connecticut Boulevard, East Hartford, Conn.

used by tool-makers for accurately locating work. Four of the buttons are fastened to the plate with small screws, and then by working from a plug in the central hole, the buttons are shifted until their center distances exactly coincide to those given in Figs. 5 and 6. When the buttons are accurately set, the master-plate is again strapped to the face-plate, and a test indicator is used to set one of the buttons perfectly true. This one is then removed so that a hole may be bored and reamed. In the same way the other three holes are bored and reamed, and the size of each is made to coincide with that of the central hole *E*. It will be seen that if the buttons are accurately set, the center distances of the holes will also be accurate, as they are bored concentric with the buttons. A piece of wire *C* (Fig. 4) is next turned to fit the taper hole in a collet, as shown, after which both the collet and wire are placed in the lathe spindle, the face-plate is removed, and the end of the wire is turned to a close fit for the holes in the master-plate. The face-plate is again screwed on the lathe spindle, and the master-plate is strapped to it with the wire plug *C* in its center hole. The recess *d* (Fig. 7) is now turned in the plate after which it is removed

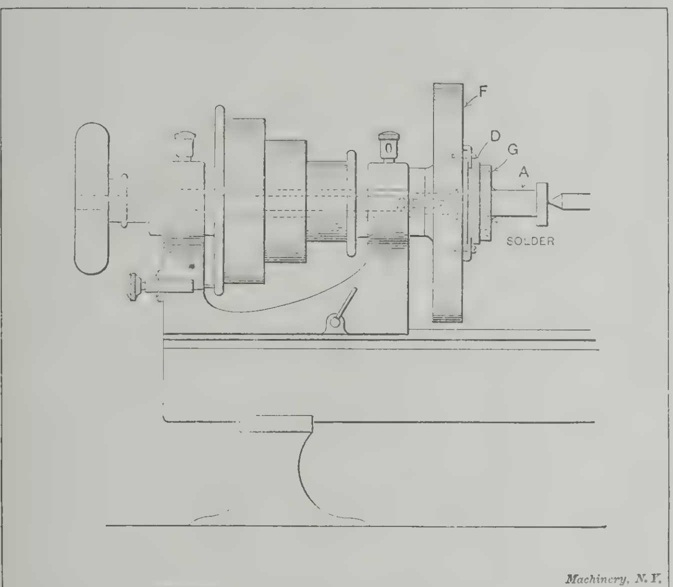


Fig. 9. Master Plate and Jig strapped to Face-plate

so that the four 3/16-inch screw holes shown may be drilled and tapped in its outer flange. A brass piece *G* (Fig. 8) is next turned and a shoulder is formed on it which is an accurate fit in the recess *d* in the master-plate. Four elongated holes are also milled in a piece *G* to match the holes in the flange of the master-plate. Piece *G* is then fastened to the master-plate, and the latter is strapped to the face-plate of the lathe, with the wire plug *C* in its central hole. A recess is then bored in *G* to an accurate fit for the small end of jig *A*, which is then soldered to *G* while the tail center is against the end, as shown in Fig. 9. The master-plate is now shifted so that one of the four outer holes fits over the wire plug in the spindle. When the master-plate is changed to a new position, care should be taken to see that no dirt or chips get between it and the face-plate, as these would, of course, impair the accuracy of the work. One of the four holes is now bored, reamed and counterbored in jig *A*. In the same manner the remaining three holes are finished, and, obviously, their location will correspond to the holes in the master-plate. When the holes are finished, the jig is easily removed by turning off the solder with a side tool. The master-plate should now be placed in its central position and a larger recess turned in *G* to fit the shoulder on jig *B*. This jig is then soldered to *J*, and four holes are drilled in it in the same manner as described for jig *A*. In a continuation of this article, a method of drilling holes in a hardened die, which was employed for special reasons, and also the way in which the drilled holes are ground, will be explained.

* * *

Plans have been approved by the Swiss State Railways for building the Hauenstein Railway, which will shorten the route from St. Gotthard to Basilea by about 40 miles.

INDUSTRIAL EDUCATION—INCREASING THE SUPPLY AND EFFICIENCY OF MACHINISTS—THE CINCINNATI PLAN*

F. A. GEIER†

The rapid development of the manufacturing interests of our country during the past decade, particularly in the metal-working lines, is yearly increasing the problem of finding an adequate supply of labor, and of a proper degree of efficiency. The system of education in this country has not, until the recent past, taken cognizance of the change of the requirements of labor that has come about through this industrial development. Manufacturers have for some time realized that the efficiency of the labor that offers itself for employment is not as high as it should be. To a large extent this is due to the fact that the great majority of applicants have not gone beyond the elementary schools, and are not prepared to meet the problems that confront them upon entering the manufacturing establishments. The courses of these elementary schools, have not been such as to hold the interest of the boys, a great many leaving the schools entirely too young and with a very poor foundation even in the rudiments of education.

Manufacturing processes are becoming more highly organized and while there is a greater subdivision of labor, I believe it is true that we need a working force to-day of greater general intelligence than in the days when simpler machines and simpler processes were employed in producing our work. A careful analysis of the conditions in any manufacturing plant, will reveal a tremendous waste, because of the abuse of machinery and tools, a low standard of work, spoiled pieces, etc., a great part of which waste could be eliminated if there were a higher degree of intelligence on the part of the workmen.

America has led the world industrially, because of the natural advantages of a large home market, and of its superior advantages as to cost of raw materials. Europe and notably Germany, largely offset our natural advantages by a superior training of its employes. Our advantages as to sources of raw materials are lessening year by year. If we are to increase our home and foreign trade we must train our employes better. The movement to this end has begun, and I am asked to speak to you more specifically as to what has been done in Cincinnati.

Cincinnati has the oldest mechanics' institute in this country. This institution, with its night classes, has been doing pioneer work along these lines for many years. It is, however, not a natural condition for young men to be compelled to get their education in this way. Boys attending these schools, tired out from the day's work, cannot make the progress that they should, and often become discouraged.

About four years ago the Board of Education of Cincinnati established manual training in the elementary grades. Two magnificent technological high schools are about completed, and in these schools such training will be given as will be exceedingly useful to the boys, as they subsequently enter manufacturing establishments. The courses comprise woodworking, metal working, foundry work, mechanical drawing, and such allied branches as physics, chemistry, etc.

You all know about the cooperative course for engineering established three years ago at the University of Cincinnati, in which boys who have passed through the high schools can enter this six-year course, working one week at the shop, and one week at the university, earning, during the period of six years, about $1,800. About 200 of these boys are now employed in Cincinnati shops. While there are exceptions to the rule, as a class, these boys have surprised their employers as to the character and quality of work they are able to do. In fact, the experience has been very satisfactory. Right in the beginning there was considerable skepticism on the part of the manufacturers and a reluctance to accept these boys. The shops to-day are offering to take on more new men than the university facilities can take care of at present.

In our own plant, we have found some of these boys available for some of our difficult work, and this is also true in

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.
† President of the Cincinnati Milling Machine Co., Cincinnati, Ohio.

other shops. I call attention to this because the experience with these engineering students has practically demonstrated to the Cincinnati manufacturers the value of educated and properly trained young men. The great mass of our employes, however, in the future, as in the past, will be supplied from those who only complete the elementary courses.

About three years ago the firm of Houston, Stanwood & Gamble established a school in their own shop, giving instructions to their apprentices during shop hours. Their experience was so profitable that about a year later the Cincinnati Milling Machine Co. established a similar school. We first attempted to operate this school at night, but because of the difficulty of insuring an attendance on the part of the boys, we soon decided to also operate this school during working hours. These two schools were noticed by other manufacturers, and were also brought to the attention of the Board of Education. After a number of conferences between the manufacturers and the members of the Board of Education it was decided, beginning with September, to operate a continuation school under the auspices and at the expense of the Board of Education. It was agreed by the manufacturers that they would send their apprentices and other young men to this school four hours per week, paying regular wages while the boys were in attendance. Over 200 boys are now enrolled and as fast as additional teachers can be provided, there is no doubt that this enrollment will be very greatly enlarged. You must remember that at present the boys that attend the Cincinnati school are all employed in machine shops. The course has not yet been brought to embrace the other industries in Cincinnati. These classes of this continuation school are limited to about 20 boys. They are taught elementary and higher mathematics, including problems in geometry and trigonometry. The whole plan of the school is to teach directly the problems that the boy encounters in the shop. The catalogues and blue-prints of the machine manufacturers of Cincinnati are the text-books, and through the cooperation of the superintendents and engineers employed in the shops of Cincinnati, the work done at this school to-day is probably more practical and more effective than of any school in this country and Europe.

The efficiency of these boys in the shop is already showing substantial improvement, and will increase as the teaching force and courses at this continuation school are amplified.

So much for the efficiency. Now as to the increase in the supply of labor. It was formerly exceedingly difficult to secure a sufficient number of candidates for apprenticeships. You can readily see that parents whose attention is now called to this new plan appreciate at once that here is an opportunity for their sons to learn a trade, and at the same time to supplement their education. It also appeals to the boy. He wants to go to work, and while heretofore he has been indifferent to his studies at school, he now finds instruction that is alive with interest. The supply, therefore, of young men to learn the trade is more than sufficient. So much already has been accomplished that I look forward to the future with much hopefulness, and I sincerely trust that other communities will rapidly imitate Cincinnati.

Let me repeat, that the big problem before manufacturers of this country is to secure a larger and more efficient supply of labor. Industrial education is the remedy.

* * *

Young (college) men who work in any first-class establishment find that men who cannot talk grammatically, that men who chew tobacco, slouch along the street with greasy overalls on, who hardly look up, who are scarcely willing to speak to you politely as you go along, are intellectually as clear as they are. That is what the young men learn. I remember very distinctly the perfectly astonishing awakening at the end of six month of my apprenticeship, when I discovered that there were three men in the paintshop, I being the fourth, who were all smarter than I was. Now when a young man gets it clearly in his head that he is made of the same clay as those other men, then his only hope, not to be outstripped, is in better education. He sees clearly enough, if he uses his eyes, that it is energy, grit, pluck, determination, ability to stick to it, character, which makes success in the manufacturing and in the engineering world.—*F. W. Taylor.*

INDUSTRIAL EDUCATION—INCREASING THE SUPPLY AND EFFICIENCY OF MACHINISTS—THE FITCHBURG PLAN*

M. A. COOLIDGE†

The Fitchburg‡ plan of cooperative education, or cooperative industrial education, as applied to mechanics, is an arrangement between the high school and the manufacturers of metal machinery, saws, engines, pumps and condensers, and other metal products, for a four years' course of apprenticeship, the first year all school work, the next three years school and shop work, one week in school and one week in the shop. The boys work in pairs—as an example, if a shop takes eight apprentices it has four working at all times. The boy going to work next week goes to the shops on Saturday before closing time, for an hour or half hour, according to the nature of the work, and watches the job his alternate is on, and then is prepared to take up on Monday morning the operations he has previously made himself familiar with, having obtained the additional information he may need from his foreman.

When the shops are able to take a sufficient number of operatives under this system, the course can be very much improved, we believe, by a special instructor in each shop whose only duty will be to attend to his boys, giving them all the time and attention necessary. We expect to carry out this feature shortly.

The Fitchburg plan differs from the trade school idea where any student may enter and go wholly through a three years' course without regard to his mechanical ability or fitness for such work, whereas we drop out the dead wood and try to bring out every boy a good, high grade mechanic. In one trade school they wanted some plumbing done in the school itself and, though they taught plumbing in this very school, they had to send out and get a plumber to do the work. With the exception of the Williamson school in Philadelphia it is, as far as I have heard, the only one where the shop part is made at all prominent.

Manual training schools have also failed in their effort to do practical work along the line of the Fitchburg plan primarily, I believe, for two reasons: They have failed to put the shop part on an equality with the academic and were not able to work under real commercial conditions. Under the Fitchburg plan the boys are paid for their time in the shops 10 cents per hour the first year, 11 cents the second year, and 12½ cents the third year. The young man taking this course has just the same standing in the high school on the football team, athletics, lectures, and all advantages as the other students and put it all over the other boys by always having some real money to do as they wish with, and enjoying that feeling of independence, human in us all.

The apprenticeship or school year commences July 1 and for two months it is a trial period exactly the same as in our former apprenticeship systems. If the boy does not care to continue he may stop, and if the manufacturer feels that he will not make good as a mechanic, he is told so. If he continues, he is under the same apprenticeship bond to go through the three years' course as formerly. We believe this form of bond, or obligation, is just as valuable as formerly, and is kept in mind by the apprentice that he has entered into a business agreement, approved and guaranteed by his parents.

The four years' course follows:

	Periods per Week
First year, all school work—	
English	5
Current events; industrial history	2
Arithmetic, tables and simple shop problems	5
Algebra	5
Mechanics, simple machines	3
Freehand drawing	6
Second year, school and shop work—	
English	5
Industrial history, civics, American history	3
Shop mathematics	7
Physics	4
Mechanism	5
Freehand and mechanical drawing	6
Third year, school and shop work—	
English and industrial history	5

* Paper read before the National Machine Tool Builders' Convention, New York, October 12, 1909.

† President of the Fitchburg Machine Works, Fitchburg, Mass.

‡ See MACHINERY, October, 1908, and August, 1909.

Shop mathematics	5
Physics	4
Chemistry	4
First aid to injured	1
Mechanism	5
Freehand and mechanical drawing	6
Fourth year, school and shop work—	
English	5
Shop mathematics	5
Physics, electricity	4
Chemistry	4
Commercial geography and business methods	2
Mechanism	4
Freehand and mechanical drawing	6

The above scheduled studies, detailed as follows, show how interesting and instructive the school work may be made:

English: Throughout the four years' course in order that he may speak and write intelligently, forms of business papers, shop terms and spelling.

Mathematics: Simple tables, lengths, areas, volumes, metric system, circular measure. General shop mathematics dealing with problems on cutting speeds and feeds, gearing, belting, strength of material. Algebra to facilitate in working out shop formulas.

Mechanism: Parts and construction of different shop tools, gearing, cutting threads, forms and action of cutting tools.

Freehand drawing: For quick shop sketching.

Mechanical drawing: To help in reading blue-prints and make up shop drawings if necessary.

Industrial history: History of iron industry, factory system and labor problems, new inventions, reading mechanical journals to keep in touch with progress in mechanical affairs.

Physics and chemistry: As applied to everyday shop practice, simple and common methods of testing iron and steel, hardening and tempering.

Commercial geography: Centers of machine manufacture, source and cost of materials, labor conditions, railroad systems, waterways and cost of transportation.

William B. Hunter, a technology man, with ten years practical shop experience, is the special instructor in charge of this work, and the subjects taught in the course as just outlined are from special text books following the shop work very closely, cutting out the old academic studies entirely.

Joseph G. Edgerly, for thirty-five years superintendent of the Fitchburg schools, has done everything possible to make this cooperative plan a success, and it has proved, up to date, that this idea as outlined is the best course along cooperative lines.

The city authorities, high school committee, high school principal, teachers, citizens, and various organizations, have done all possible to make it such a success that the apprentices, their parents, and the manufacturers seem pretty well satisfied that here is a line of study and work on an actual commercial educational basis.

The scheme is adopted and worked out to fit our conditions along University of Cincinnati lines, as conducted by Prof. Herman Schneider, to whom we owe a great courtesy for the attention he has shown us.

* * *

HOW JOHNNY FORCED IMPROVEMENTS

E. B. GAFKEY*

At one time when the writer was roving around the eastern part of the United States, he happened to find a position with a firm that manufactured a line of small machinery and factory supplies. The man that built the shop had the foresight to take advantage of an unfavorable location, for the factory was located on the side of a hill, with the railroad siding on top. The shop was two stories high on the railroad side, and four in the rear. Our heavy tools, erecting and shipping rooms were on a level with the shipping platform, while the light tools were placed in the two stories below and were connected with the receiving platform by slides or chutes lined with light tank plates. The company used a vast quantity of small castings and forgings, which they did not make. These were received in barrels and boxes which were unloaded from the cars to the platform and thence down the slides to their respective departments where they were machined, finished, and placed in storage bins for use when wanted.

Our superintendent was a man, who, according to the way he talked, had never had a man in his employ who had ever done a fair day's work for the firm. He said they always worked and walked as though they were going to a funeral; but as no one paid any attention to him, we took it for granted that he was a natural grumbler, and let it go at that. However, one day things took a change, and it all happened on account of a small casting and a sharp order to hurry up, and the order didn't come from the superintendent either. That particular day my partner and myself were assembling a machine, when one of the parts used proved to be defective, and our helper, whose name was Johnny, was told to go downstairs and get another, and to be quick about it. He was quick, all right. Instead of going down the elevator or stairs, of which there were two of each, he went into the gangway at the top of the chutes where someone had left a scoop. Here was a chance. What's the use of going down two flights of stairs or waiting for a pokey elevator? Why not slide down? So suiting the action to the word, he seized

"The superintendent tried to dodge, but couldn't make it, and Johnny caught him just below the midship section"

the scoop, and after firmly seating himself therein, he placed the casting in his lap and "cut loose." Well, I suppose everything would have been all right, but when Johnny reached the bottom he had attained a speed of about fifty miles an hour, and it happened, at that instant, that the superintendent was just in the act of crossing his path. The superintendent tried to dodge, but couldn't make it, and Johnny caught him just below the midship section. The next instant there was a deafening crash as superintendent and Johnny landed in a pile of empty barrels stored near by. About two seconds later, Tom, the foreman of that floor appeared with "What the h—l is that leather-headed clerk sending material down here for without letting me know?" But there was no material in sight. Johnny managed to get out of the wreck first, and then stood in open-mouthed wonder, his eyes as big as moons, expecting to get fired; but nothing of the kind happened. The superintendent, with Tom's help, managed to scramble to his feet, and as he shook the loose barrel hoops from his person, straightened up as far as his one unbroken suspender would allow and says, "Well, I'll be d——d. There is nothing so important around here that any one has got to be so quick that they have to use that blamed slide."

Johnny got his casting and returned, while the superintendent went home to change his dishevelled appearance, but inside of fifteen minutes after the affair happened, the shipping clerk posted two big, glaring notices about the danger of using the slides, and that afternoon the millwright put up a sliding gate in front of them, with an electric bell at the bottom that would always ring when the gate was up. But that was not all. The next day, a gang of electricians appeared on the scene and installed a complete telephone system connecting the different departments.

One day shortly after, my foreman came to me and said: "Ted, that helper of yours deserves a medal. By using the superintendent to break up a few old barrels, he got more improvements in five minutes than all the foremen in the shop have been able to get in the last five years." We never heard any more talk of "moving faster" from the superintendent.

* Address: 16023 Hilliard Road, Lakewood, Ohio.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

DEFECTS IN JIG DESIGN

The first consideration of the jig designer should be to determine what degree of accuracy is absolutely essential in the part that is going to be produced and also whether absolute interchangeability is necessary. This information will be a guide for the economical production of the jig. The designer should also consider any operations which are to be performed on the work prior to the one for which the jig under consideration is intended; for while this preliminary machining may not need to be accurately done, inaccuracy or ununiformity may result in improperly locating the work in the next jig, which should be so designed as to locate the part with the required accuracy. The writer's experience is that many jigs have been designed by those who have not considered the points mentioned in the foregoing.

Again, the locating parts of any jig should be such as to allow as wide a range of inaccuracy on any preceding operation which may be performed, as is compatible in the part. For example, if the part has to be turned to say a limit of 0.001 inch, it will require more skill and time than if a limit of 0.005 of an inch is allowable. Again, as far as practicable, the portion of the work that requires to be the most accurate should be used in locating it in the jig for the succeeding operation. Often a surface is selected to locate from which,

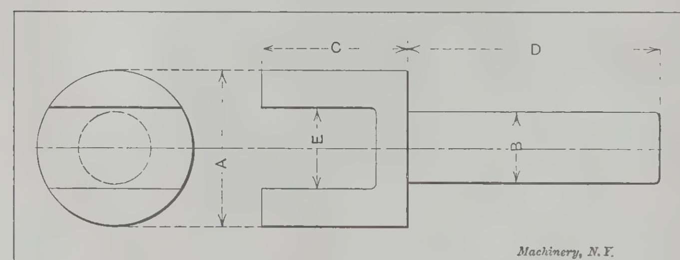


Fig. 1. Work which is milled as indicated at E

in consequence, has to be machined to an accurate limit, but which accuracy otherwise would be unnecessary. This, of course, only adds to the cost of production. After considering the points mentioned, the best method of arranging the details of the jig so that it has as few dimensions as possible requiring absolute accuracy, should also receive attention. That is, the jig should be as simple as possible, and still be so

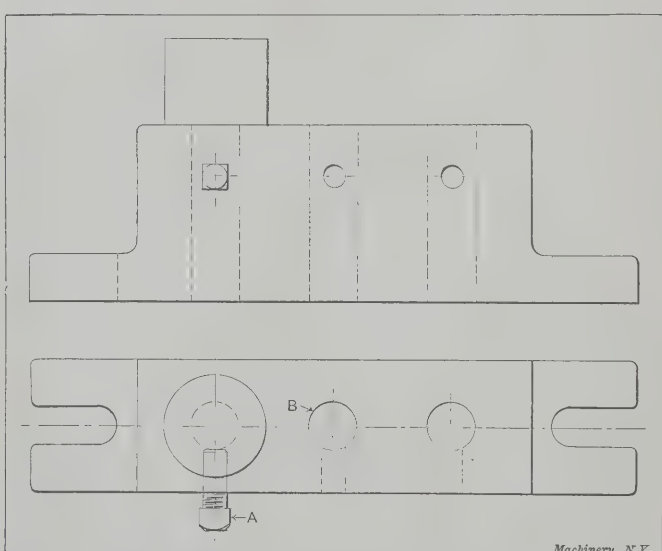


Fig. 2. Defective Design of Fixture for Holding Piece shown in Fig. 1

designed as to accurately locate the parts to be machined. Sometimes jigs are so designed that owing to the arrangement of the details, much time is expended in making test pieces to determine their accuracy.

In Figs. 2 and 3 are shown two jig designs which will serve to illustrate the points we have in mind. The part for which a jig is required is shown in Fig. 1. In the preliminary machining operation the work is turned to diameters *A* and *B* and to lengths *C* and *D*. The limit of accuracy required on end *A* is — 1/64, or any diameter from 1 39/64 inch as a minimum to 1⅝ inch. For end *B* a finer limit of — 0.002 is necessary, so that this end should be used as the locating part for the next operation; *viz.*, the milling out of the slot *E* which must be central with the part *B*. A design

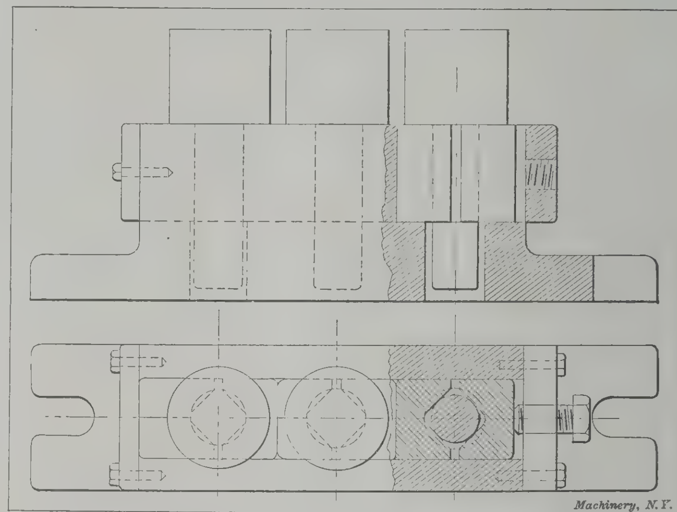


Fig. 3. Fixture which will hold a Number of Pieces, Fig. 1, properly, even though Diameters of Locating Parts vary

such as shown in Fig. 2 is not uncommon for this operation, and with it fairly accurate results will be secured; but if we assume that the locating diameter on the work is slightly small, say 0.002 inch, then forcing the piece over to one side by the locking screw *A* will result in an inaccuracy in the milling operation. The locating holes *B* must be the exact size of the locating part of the work, and unless every piece is a push fit (which is unnecessary accuracy in the part) the location is not accurate as the work is clamped against a

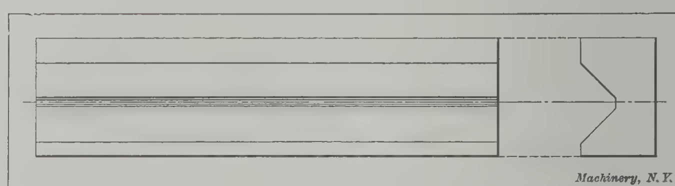


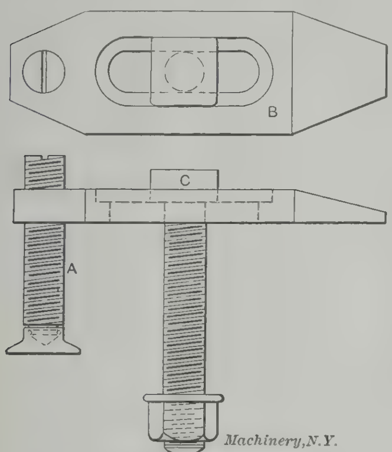
Fig. 4. The Way the V-blocks for the Jig, Fig. 3, are planed

small area on one side of the hole and the point of the set-screw on the other. This can be avoided by locating the part against V-blocks as shown in Fig. 3, which locate each shank central, irrespective of the variations in their diameters. The construction of this jig illustrates the points which have been referred to. The V-blocks provide four lines of contact, and the part is secured very rigidly in a central position irrespective of the variations in the diameter of the locating part. This jig, though more expensive than the one shown in Fig. 2, is quite simple in its construction. A central slot is machined to a width which need not be to any particular dimension as the steel V-blocks will be accurately fitted to this slot. Steel plates are secured to the ends of the jig after machining the slot as shown. By closing these ends after the slot is machined, the tool has a clear passage through, which, of course, would be impossible were the ends cast on. The V-blocks are planed in one piece, as shown in Fig. 4. The only important dimension is the width of the block. The exact position of the V in relation to the sides is immaterial provided that after the blocks have been sawed off they are inserted in the slot in the jig with the long or short sides together. To avoid trouble from this source, one side of the slot and a corresponding side on the blocks should be marked to ensure the correct insertion of the latter. In the event of a design requiring the V's to be strictly central with the sides, the cost would, of course, be increased, as much more care would be required in machining. The jig shown in Fig. 3 is for holding three of the pieces shown in Fig. 1 at one time. Obviously, this number could be increased as desired.

CONTRIBUTOR.

AN ADJUSTABLE STRAP

One of the neatest and most convenient face-plate straps that I have seen is shown in the engraving. How tiresome it is to hunt around the shop after blocks and pieces of the right height to line up the strap to a parallel position with the work to be machined. As will be seen, the rest *A* of this strap is easily adjusted to the proper height. Another desirable feature is that the oblong hole for the clamp bolt permits the strap to be located in the most desirable position by sliding it to and fro. A set of these straps of different sizes can be made with little extra expense, which will be more than offset by the saving in time. The strap *B* should be made of tool steel so that it will be stiff, and the elongated hole should be milled to fit the head of the bolt *C* in order to avoid the use of two wrenches and facilitate the handling of the work. The end of the strap is drilled and tapped for a suitable sized screw *A*, which has a shoe on the bottom to prevent marking the face-plate. This shoe is held in place with a pin to keep it from dropping off. A. L. Monrad.



An Adjustable Strap or Clamp for the Face-plate

East Hartford, Conn.

A LATHE SPINDLE KINK

There is one very simple point in connection with the manufacture of lathe and milling machine spindles which builders in general would do well to consider, as I think it would result in great good to the Christianity of machinists and toolmakers, as well as being a profit producer to users of these machines. In order to briefly state the case I will relate a circumstance that occurred in actual practice, which is similar to several others of my own experience.

A new lathe had been in the shop for a considerable time, and when I had occasion to put the face-plate on the spindle I found it to go extremely tight, in fact it would not go up to the shoulder, which was, of course, aggravating and also a hindrance to progress; then I proceeded to take it off and spend about five minutes trying to clean the dirt out of the internal threads, though not succeeding very well. I finally wound up by getting out of patience and doing the job with the face-plate standing away from the shoulder. At my first opportunity I said to a toolmaker: "What is your private opinion as to the proper shape for the starting end of a thread on a lathe or milling machine spindle?" to which he replied: "It's a small question, I never gave it a thought." Then I told him of my grievances with the tight face-plate and he told me that when that lathe came into the shop the chuck and face-plate both went on all right and it was his opinion that someone must have strained the first thread. My convictions on the subject were that if the end of the thread were cut off straight instead of being left wedge-shaped (as it commonly is), the blunt end of the thread would scrape all the dirt out of the chuck thread as it entered; therefore there would be no dirt left to wedge in the thread, which was the cause of the tightness. The toolmaker was open for conviction and asked me to show him, so I took a small chisel and started at the place where the thread came to its full size and cut out a piece of the first thread about one inch long, which left a gap or open space in the thread. We then put the face-plate on and found that it went easy clear up to the shoulder. When the face-plate was taken off again, the gap in the thread was nearly filled up with dirt and chips which the end of the thread had scraped out. This spindle will always clean the thread ahead of itself and it is a source of permanent economy.

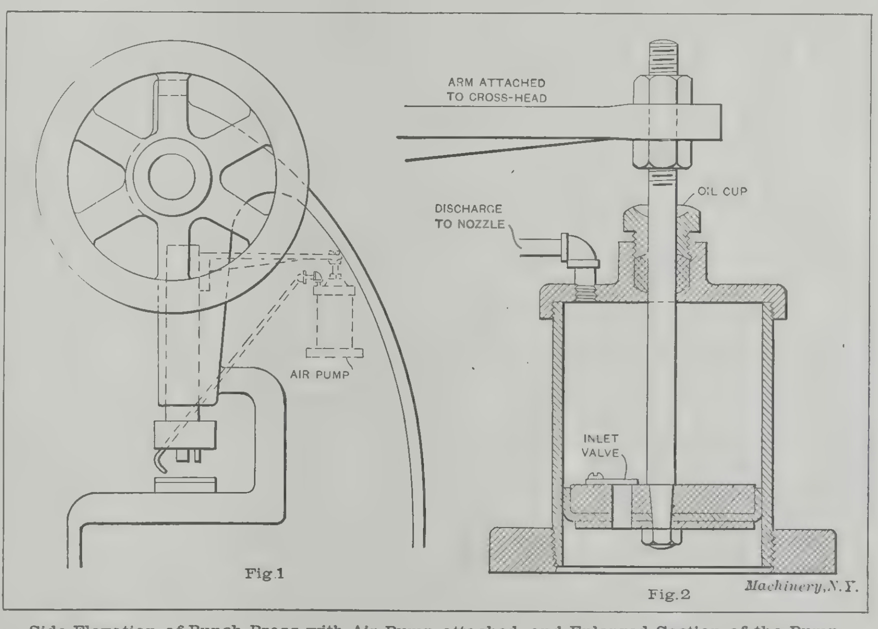
We take it for granted that a man should not put a chuck or face-plate where it will get dirt into it, but that does not change the fact that he will do it just the same; first because of carelessness, and second because he has something else to do besides taking care of the tools. Then again, even though all possible care is used, dirt will sometimes get into the threads so that it is better to adopt this simple method and put a stop to all future troubles in this line.

Here is another valable pointer concerning threads. In many cases where case-hardened finished nuts are used on soft bolts for the planer, slotter, milling machine, or almost any machine in the shop (especially where oil is used) the finer chips will accumulate in the nut with the result that the nuts are soon tight, and someone is blamed for straining the bolt. After a hand die is run over the bolt, if the nut is still tight, some have been known to get the tap and try to put it through the case-hardened nut. Here is a little kink that will overcome the difficulty: Take the corner of a file and file a notch down to the bottom of the thread of the bolt and in the majority of cases the nut will go on easily. The notch does not need to be large enough to damage the strength of the thread very materially.

Bridgeport, Conn. H. E. Wood.

EJECTING WORK FROM THE PUNCH-PRESS WITH COMPRESSED AIR

The article by Mr. Barnes in the August number of Machinery descriptive of an arrangement for blowing away finished stock from a punch-press, recalls to the writer's mind a device designed and built by him to accomplish the same result. As there was no compressed air of sufficient pressure available, an independent pump was attached to the press, as shown in Fig. 1. The piston-rod of this pump is connected directly to the cross-head of the press, and, consequently, the pump has the same stroke as the throw of the crank-shaft. The air is compressed on the up stroke, and it is delivered against the work by means of a ⅛-inch pipe which is fitted on the end with a nozzle. The pump cylinder is made of a piece of 3-inch brass tubing which is screwed into a base-plate, as shown in the enlarged sectional view, Fig. 2. This tubing is fitted with a head containing a stuffing box, and a ⅛-inch pipe outlet. The piston is a regular 3-inch hydraulic cup, and a piece of leather belting is used as packing. A piece of leather fastened by one screw to the inside of the piston, covers a ⅜-inch hole and acts as an inlet valve. The finished work has an upturned portion on the front end, and the nozzle is



Side Elevation of Punch Press with Air Pump attached, and Enlarged Section of the Pump

placed so as to direct the blast against this point. This arrangement has also been used to blow away small scrap.

Baltimore, Md. BENJAMIN E. TEALE.

HANDY TABLE FOR THE SOLUTION OF RIGHT-ANGLE TRIANGLES

The table below gives in a convenient form the rules necessary for solving right-angle triangles. To the toolmaker or apprentice who has not had the privilege of becoming familiar with trigonometry, it is put up in a very handy form for reference. There are a great many who do not understand the meaning of "square" and "square root," and who will find

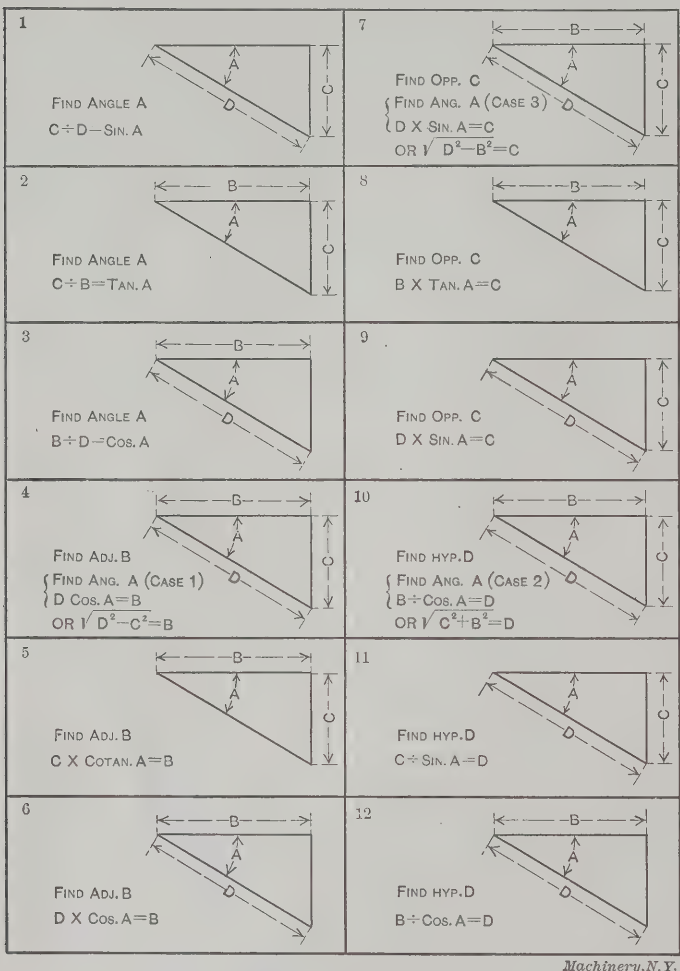


Table for Solution of Right-angle Triangles

it easier to first find the angle when two sides are given, and then find the required measurement of the third side from the angle by the rules as stated. It will be noted, however, that the formulas giving the length of the third side when two sides are given in the form of a square root is also included.

F. J. BOUVE.

Wenham, Mass.

FILING DRAWINGS

Commenting on recent articles by Mr. Breath and Mr. Davis on the sizes and filing of drawings, permit me to say that I have been employed where this matter was long ago settled in a very satisfactory manner. The filing cases used are 17 x 23 inches inside, practically, the intention no doubt being to have them 18 x 24 inches outside measurement. They are made of very heavy cardboard, cloth covered, and are sold by nearly all dealers in office supplies. Their supposed use is for the filing of legal documents, etc., as well as maps and drawings.

The largest drawings used are 16 x 22 inches, with a half-inch border all round, thus reducing the space inside the border to 15 x 21 inches. Then there are other drawings 8½ x 11 inches, the size of an ordinary sheet of letter paper. The filing cases cost a dollar and a half each, and open along one edge in a manner that permits of easy withdrawal of the contents. These filing cases are placed in a case on their back edges, so the contents are always in a vertical position. They occupy a minimum of office space in this way, and are very convenient for reference. The drawings are divided by subjects, and heavy folders such as are used in vertical filing cabinets are made from detail paper. The boxes containing the smaller sized drawings have a thin partition down the middle. When the scheme was started it was alphabetic and each envelope had on it the name of the work contained on the sheets of drawings in it. Now, however, the system is a numbered one, and there is a card index for reference.

Small drawings have come to stay because of their convenience, and this filing scheme I mention is certainly inexpensive and being on the vertical plan with heavy paper folders, is capable of indefinite expansion.

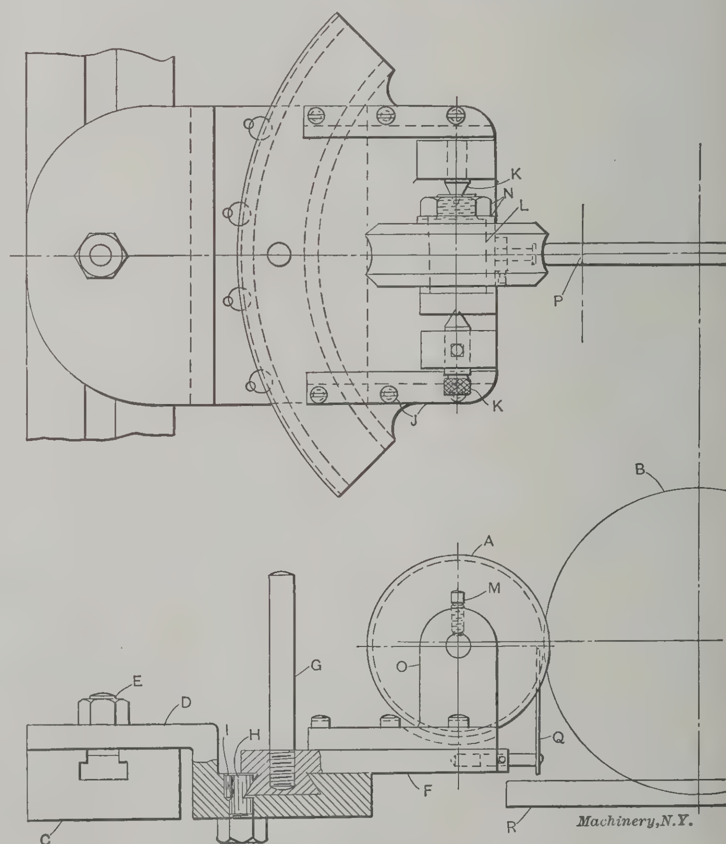
Chicago, Ill. JAMES DAVIDS.

FIXTURE FOR GRINDING RADIUS CUTTERS

Some of the parts on our automobile transmission which have to be milled can best be done with radius cutters, and as it is necessary to use an old grinder to keep these cutters sharp, this necessitated a fixture of rather an odd design.

The reason for this odd design in the fixture is that the grinder has no fixed method of adjustment, and this feature was rather hard to overcome, as it was absolutely necessary to have an adjustment to take in several sizes of cutters, and get a circular movement; provide for clearance; do without a pivot, and all perpendicular adjustment.

The construction of the fixture can be understood by referring to the engraving which shows a plan and a side view partially in section. The lines *A* represent the largest size cutter, and *B* the standard size of emery wheel for this grinder. *R* is a fixed table and *C* the platen with a horizontal



Special Fixture for Grinding Radius Cutters

motion only, which in this case was required to remain stationary. Thus it is seen that this grinder was not convenient for this class of work. The stationary support *D* for the fixture is clamped to the grinder by T-bolt and the nut *E*. *F* is a movable body, *G* a steel stud to be used as a handle in moving *F* back and forth in a semi-circle, *H* brass studs which are prevented from turning by dowel pins *I*, and which are beveled to fit the projecting tongue on *F*. As the four studs *H* are brass against cast iron, and in a corresponding radius to the tongue on *F*, provision is made for wear and accurate adjustment, while a circular or radius motion is obtained without a pivot. In this particular case a pivot

joint would necessarily come in the way of either the cutter *A*, emery wheel *B*, or table *R*.

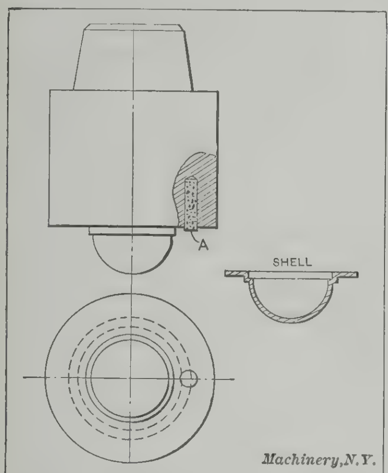
The required horizontal adjustment for the various size cutters is obtained by moving cutter holder *O* toward or away from the center *P*. This holder is clamped in place by side strips and screws *J*. The cutters are fitted to arbor *L* and clamped by a nut and washer *N*. The arbor is mounted on centers *K*, one center being movable for removing or replacing the arbor. The correct spacing is provided for by adjustable stop *Q*.

This gave us a practical fixture for this work on a machine of little value, and thus the fixture soon paid for itself.

JIG AND TOOL DESIGNER.

STRIPPING SHELLS THAT ADHERE TO THE PUNCH BY OIL CONTACT

A simple and very successful method used in connection with the drop press for stripping small shells that adhere to the punch by oil contact, is illustrated in the accompanying sketch. The principle is the same as that of the method described by Mr. C. Howell Dockson in the August number of MACHINERY, for stripping cup-shaped drawn shells, although perhaps of a cruder nature. The stripper consists of a stiff piece of rubber *A* inserted in a small hole in the punch, the end of which projects 1/32 inch below the surface of the punch. This rubber should be of proper size to hold itself in place by friction. In some cases it is preferable to locate the rubber in the center of the formed portion of the punch. Of course, the rubber has to be renewed occasionally on account of deterioration. The frequency of renewal depends on two things: Namely, the amount of pressure required to strip the shells and the grade of rubber used. It is safe to say that one rubber will do for from 1,500 to 2,000 gross of the piece being formed, without renewing. Rubber of the right size should be kept on hand so that worn-out pieces may be quickly replaced.

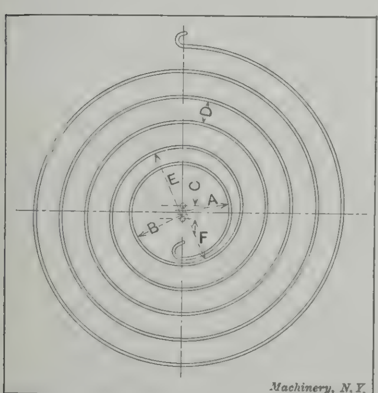


Punch with Rubber Insert A, which Sheds the Shell held by Oil Contact

Winsted, Conn. CHARLES RICHARDS.

LAYING OUT A SPIRAL

It is seldom that a draftsman has occasion to draw a spiral of many turns (like a watch spring) and when the occasion does arise, recourse is had to some handbook which usually gives the method of four centers. The use of the two center method with semi-circles, I find to be sufficiently accurate, much more rapid, besides giving a smoother job by reason of fewer joints. While this method is not at all new it does not seem to be commonly known. The engraving shows a drawing of a spring, made by this method. Starting at the inside with radius *A* from the actual center, draw a semi-circle at the right of the vertical line. With radius *B* (equal to *A* plus thickness of spring) find center below true center from which the arc will connect with the arc struck by *A*, and draw the semi-circle at left of vertical, thus completing the first turn. Having decided on the pitch *D*, two centers are next located on the vertical, one being ¼ *D* above true center, the other ¼ *D* below true center; thus $C = \frac{1}{2} D$. From the upper center with a radius *F* draw the semi-circle at the right of vertical and from the lower center with a radius *E* connect with end of arc *F*, and draw the semi-circle at the left. By thus changing centers and increasing the radii the spiral is easily produced. RALPH W. DAVIS.

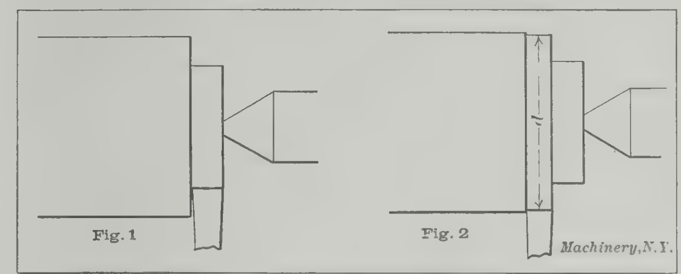


A Spiral Laid Out by the Two-center Method

Rochester, N. Y.

CUTTING A DOUBLE THREAD

Among machinists it is generally known that when the number of threads per inch of a screw being cut is an exact multiple of the number of threads per inch of the lead-screw, the split-nut may be disengaged at the end of each cut and re-engaged at random when beginning a new cut, there being no need to stop or reverse the lathe. In the case of screws having a number of threads which is not a multiple of the number of threads per inch of the lead-screw, it is necessary to have recourse either to some means of insuring the correct re-engagement of the split-nut and screw, as by the use of an indicator designed for the purpose, or by keeping the lead-screw and nut always in mesh and reversing the lathe, thus bringing the carriage and thread tool back to the starting point. It may not be generally known, however, that when the lead of a double-threaded screw is exactly twice that of the thread on the lead-screw of the lathe, such a screw can be cut without stopping or reversing the lathe or employing timing or other devices. To illustrate, if a double-threaded screw having say, ½-inch lead were being cut on a lathe, provided with a lead-screw of ¼-inch lead, the split nut could be engaged at any time and the tool would always follow in one of the two thread spaces.



Figs. 1 and 2. End of Blank turned to Depth of Thread and to Depth of First Cut

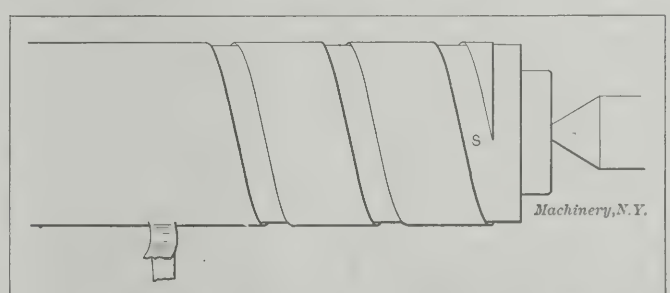


Fig. 3. Tool taking the First Cut on a Double-thread Screw

The accompanying engravings illustrate the method employed by the writer when cutting double threads, the lead of which is twice that of the lead-screw, which enables the work to be done very quickly. As shown in Fig. 1, the end of the work is first reduced to the diameter of the bottom of the required thread. In repetition work, this operation would first be completed on all the pieces to be threaded. It could, however, be omitted entirely if the lathe is equipped with an indicator or stop to give the exact depth. The practical man will no doubt have observed that in cutting a square thread, the moment the tool meets the work, it lags behind slightly. This is due to the fact that the tool is held up or is cutting at this moment only on its leading edge; consequently it yields more or less according to its stiffness or rather lack of stiffness. Hence it is often necessary to cut away a portion of the leading end of the screw. When performing the operation indicated in Fig. 1, allowance should be made for this distortion of the thread.

The next step is to reduce the end, as shown in Fig. 2, an amount equal to the depth of one cut. The split-nut is then engaged with the lead-screw at random, and the first cut taken along the work as shown in Fig. 3. When the carriage is brought back (by hand) to the starting point, the tool is set against the reduced end, as in Fig. 2, and the split-nut is engaged with the lead-screw immediately after the opening of the thread space S (Fig. 3) has passed the point of the tool. The tool will now take a second cut midway between the turns of the first, as shown in Fig. 4, and the depth of the second cut will also be equal to that of the first. When the tool is again started the diameter d (Fig. 2) is reduced an

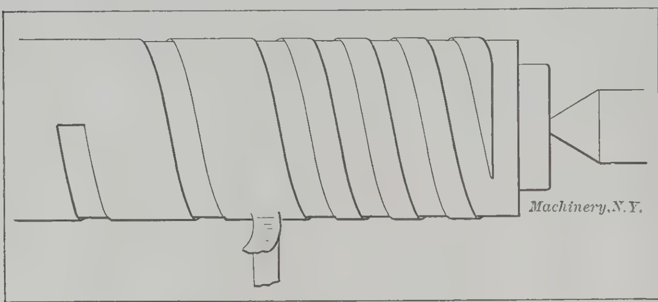


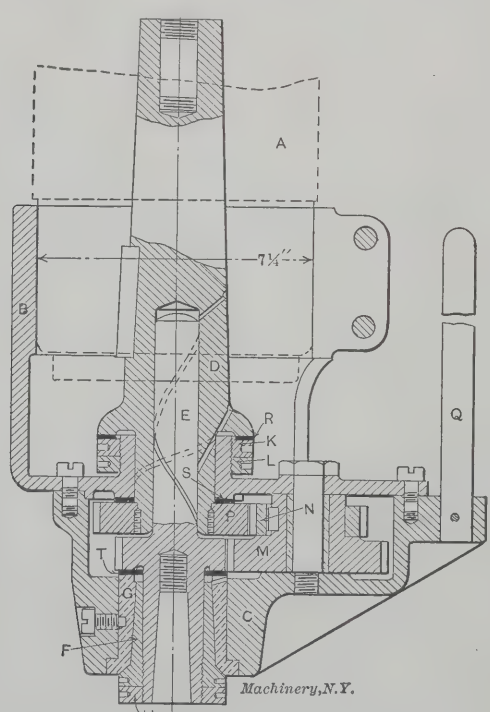
Fig. 4. Tool taking the Second Cut

amount equal to the desired depth of the cut, and the split-nut engaged at any point. Then when the succeeding cut is taken, it is again necessary to engage the split-nut at the proper moment; that is, when thread space S has just passed the tool. This operation is repeated until the thread is cut to the correct depth as shown by the coincidence of the tool point with the reduced end, or by a stop if the lathe is so equipped. In one instance within the writer's experience, the replacement of the old method by the one here described reduced the time per piece from about one hour to twenty minutes, or an increased output of 300 per cent.

Coventry, England. FRANCIS W. SHAW.

SPEEDING HEAD FOR VERTICAL MILLING MACHINE

The high-speed milling attachment illustrated herewith was designed to fit an Ingersoll milling machine, the spindle speed of which was too slow for some classes of work. The attachment is designed so that it is easily attached or removed

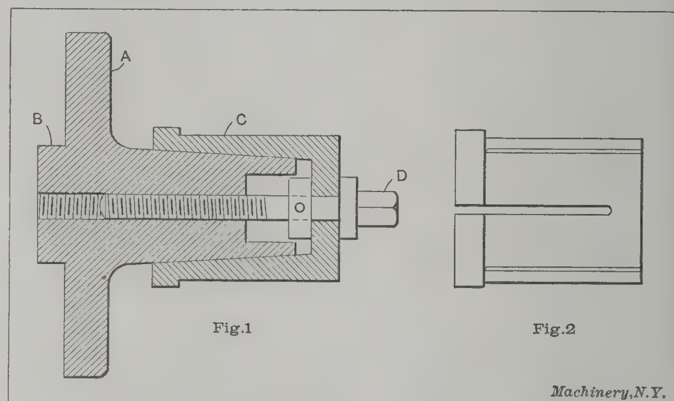


High-speed Attachment for the Vertical Milling Machine

from the machine. The following is a description of the construction of this attachment as made in the Thomson-Houston shop of the General Electric Co. The casting B was bored to fit the outside of the spindle A. The part B is fastened to the spindle by two bolts as shown. The gear case C is centered with the spindle by a boss on B, and it is bored out to receive the brass sleeve G, which forms a bearing for the conical, tool steel, hardened sleeve F; the latter is screwed on the milling cutter holder E. The upper end of E has a bearing inside the part D which fits into the spindle and is keyed to it. On D is fixed a gear P, which drives the holder E through the gears N and M. The attachment is prevented from turning in either direction by a stud Q, which comes into contact with the machine head. The box C forms a reservoir for the oil into which the hardened steel gears run constantly. Spiral grooves are cut in all bearings, and fiber washers are used at R, S and T as thrust washers. The nut H permits compensating for the wear that may take place in sleeve G. This device, as before stated, is very easily attached to the machine, and the only change that was necessary in the latter was to cut a keyway inside of the spindle for the key which drives the shank D. P. P. F.

FIXTURE FOR TURNING AND FACING COLLARS

As we have quite a number of collars to make, the fixture shown in the sectional view, Fig. 1, was made for holding them while they are being turned, faced and polished. This fixture has a disk A which is fastened to the lathe face-plate and centered by a boss B. The projecting end of this disk is turned to a taper of ⅝ inch per foot, and on this tapered part



Fixture with Expanding Sleeve for Holding Collars while Turning and Facing them

is fitted a flanged sleeve C. This sleeve has six ⅛-inch slots cut into it, three being cut from each end and extending to within ⅜ inch of the opposite end, as shown in Fig. 2. These slots permit the sleeve to expand when it is forced upon the tapered part by the screw D, which fits into A. As the collars for which the fixture was made are slightly longer than the expanding sleeve, they can be turned on the outside and faced on the end at one setting of the tool. They can also be very quickly placed on or removed from the fixture by simply turning the screw D in the proper direction. The ends of the collars can be easily polished, as it is not difficult to get in the corner with the polishing stick as when using an ordinary mandrel. One hundred collars were made on this fixture in ten hours' less time than was required when a mandrel was used. L. J. GETZ.

Salem, O.

DON'TS FOR SCREW MACHINE OPERATORS

Don't use a box tool for a roughing cut; use a hollow mill.

Don't use a cut-off tool without some top rake.

Don't put an extension on a wrench when trying to make a tool hold; if the tool slips after tightening with the proper wrench something is wrong.

Don't use a steel hammer for adjusting tools; have a copper one handy and some pieces of brass of different sizes and lengths.

Don't use a monkey-wrench; show the boss how much cheaper it is to standardize the screw heads and furnish proper wrenches.

Don't put a new bar of stock into the machine without measuring the first two or three pieces that come off.

Don't measure up a piece of work without measuring all of the dimensions.

Don't change collets or jaws without cleaning out the spindle nose.

Don't put a screw-driver into the slots of a feed finger to loosen it; use a spanner or a pin in the holes provided.

Don't use a cut-off tool which is too narrow; a wider one can be pushed faster and it will stand up better and leave a better finish.

Don't throw in the feed until you are sure everything about the machine is all right.

Don't let the first few pieces get by without looking to see if the feed finger is scratching the work.

Don't move a tool after measuring just one piece; it is better to measure two or three, as any automatic will make a piece now and then which will be out.

Don't put a new bar of stock into an automatic in a haphazard manner; different jobs require different ways of starting a new bar.

Don't let your machines run without measuring the work often.

Don't take two roughing chips if one is possible; use a little finer feed and only take one chip.

Don't let the tools get choked up with chips; clean them out once in a while.

Don't say you can't do a hexagon or a square job just because you haven't a collet; a round one will hold both square and hexagon on a pinch.

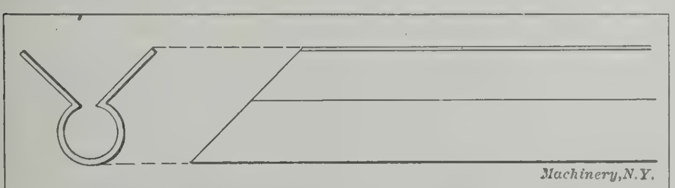


Fig. 2. Corner Piece formed by the Die shown in Fig. 1

Don't run the feed belts too tight; when a trifle loose, if something sticks they will slip and not smash things.

Wilkes-Barre, Pa. PAUL W. ABBOTT.

PRESS TOOL FOR BENDING CORNER PIECES

A press tool is shown in Fig. 1 for forming in one operation the copper corner-piece for lamp frames illustrated in Fig. 2. These corner pieces vary in length from 8 to 36 inches. The copper from which they are made comes in rolls cut to the width required, and they are cut to the right length in the press with an ordinary punch and die, which also forms the ends so that they will fit together when placed in position on the lamp frame.

The construction of this bending and forming die is clearly shown by the side and end elevations, Fig. 1. The forming punch *A* is fixed into punch-holder *B* by taper pins *C*. This punch is made in two pieces as shown in the end view. The punch *D*, which also acts as a mandrel on which the cylindrical part of the corner-piece is formed, is made a sliding fit in *A*. The two forming slides *F*, which fit in slots in the casting *H*, are normally held open by helical springs *J*, which are compressed between fixed studs.

When the press is on the upper part of its stroke, punch *D* is forced to the bottom of the slot in *A* by the springs *E*. As this punch descends, it bends the stock to a U-shape between the slides *F*, which are then forced inward by the finger-cams *G*, thus forming the corner-piece against the lower ends of *D* and *C*, to the required shape. While the slides *F* are at work, punch *D* moves upward with relation to the slot in *A*, and, at the end of the downward stroke of the press, it occupies the position shown. In order that *D* will not begin this upward movement as soon as it comes into contact with the stock and begins bending it, pins *K* are inserted into it which fit into the right-angle slots cut through one side of the punch *A* as shown in the side elevation. When the downward stroke begins, these pins are in the part *k* of their slots. When it is time for *D* to begin its upward movement, it is forced to the left by cam *L* so that the pins *K* are brought in line with and can ascend the vertical parts of the right-angle slots.

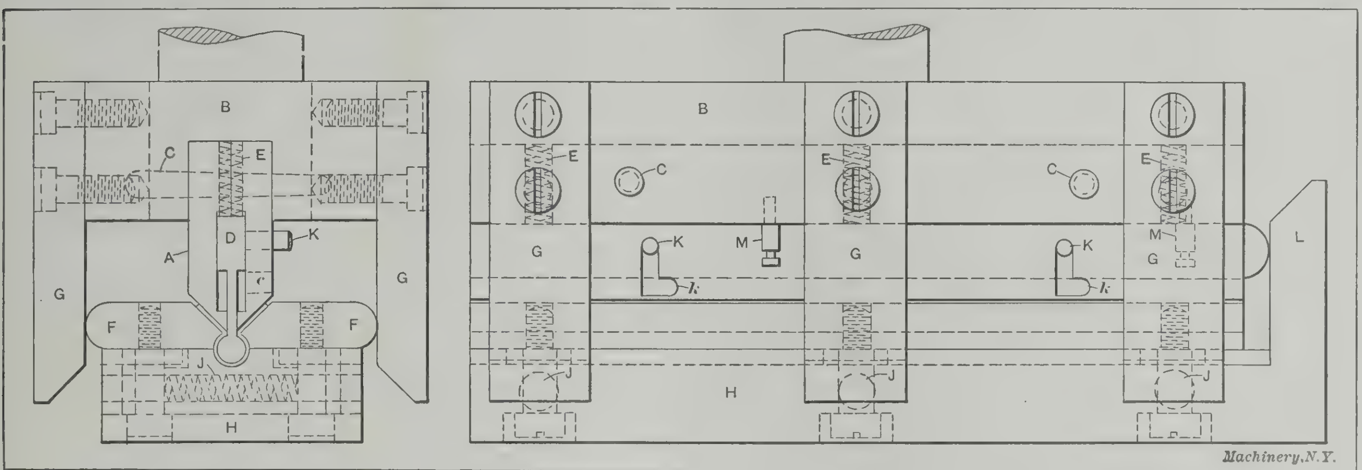


Fig. 1. Side and End Elevation of a Bending and Forming Die for Forming in One Operation the Piece shown in Fig 2

When the press begins the upward stroke, *D* begins to descend, being forced downward by the springs *E*. When pins *K* reach the bottom of the vertical part of their slots, springs (not shown) which are attached to them and to the pins *M* in the punch-holder, draw punch *D* to the right. The pins are then once more in the right-hand end of the horizontal part of the slot, or in position *k*; the punch is then ready to begin bending a new piece.

The gages or stop-pins for the stock are not shown, but are fixed on the slides *F*. These two slides come against a dead stop each time they are opened by the springs *J*. The punch *D* should be an easy fit in the slot in *A*, and the cam *L* should come in contact with this punch before it can bind the stock against the die, so that it can slide freely to the left or in a position that will enable *A* to descend. This tool should be used in a press having at least a 2- or 3-inch stroke, as it would not work well in a press having a shorter stroke than this. C. PETITJEAN.

London, E. C.

LATHE ATTACHMENT FOR BACKING OFF TEETH OF STEPPED REAMER

We had orders for about 200,000 gas cocks, the bodies of which had to be drilled and reamed. When this work was started there was considerable trouble as the reamer would clog up with chips and break because it had to remove so much stock in reaming the large end of the hole. In addition, the hole was distorted so much that there was always trouble when grinding the seats. This trouble, however, was eliminated after the tool shown in Fig. 1 was designed, which enabled the drilling and reaming to be done in one machine, and at the rate of 8 per minute or 480 per hour. This combined drill and reamer prevented the breaking of the finishing reamers and made it possible to grind the plugs in the body in one quarter the time previously required. It was necessary in order to secure satisfactory results to have the cutting edges on each side for the different steps, in the same plane, and in Fig. 2 is shown a diagrammatical view of the attachment used for backing off the cutting edges of the different

steps. It consists of casting *A*, which is threaded to fit the lathe spindle, carrying on its face two raised surfaces or cams *B*, which for this particular job are located 180 degrees apart. The shape of each of these raised surfaces corresponds to the required shape for the clearance. Bearing against the plate *A* and in line with cams *B* is a roller *C*, mounted in a shank which in turn is fastened to the cross-slide of the lathe carriage. The work *D* is held in a hole in the center of the casting *A* by suitable means. When the lathe is to be set for cutting clearance on the reamer, the roller *C* is brought in contact with the highest point of one of the cams as shown

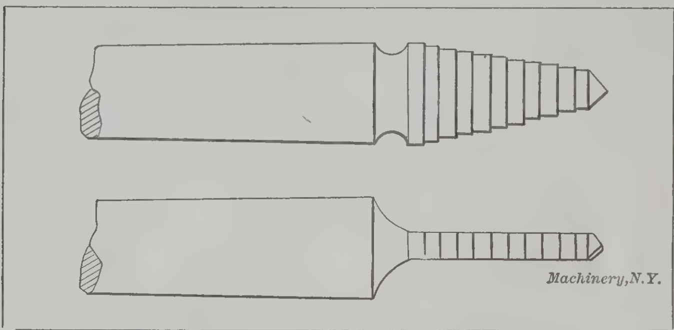


Fig. 1. Combined Drill and Reamer after the Turning and Milling Operations

in the illustration. The cutting point to be backed off and the turning tool are then set so that they just touch each other. By keeping a constant pressure on the hand-wheel at the side of the carriage, the cams as they come in contact with the roller will cause the carriage to advance and return at just the proper moment to give the required form to the cutting edges. Of course, if the work has more than two cutting edges to be turned, it will be necessary to have as many cams

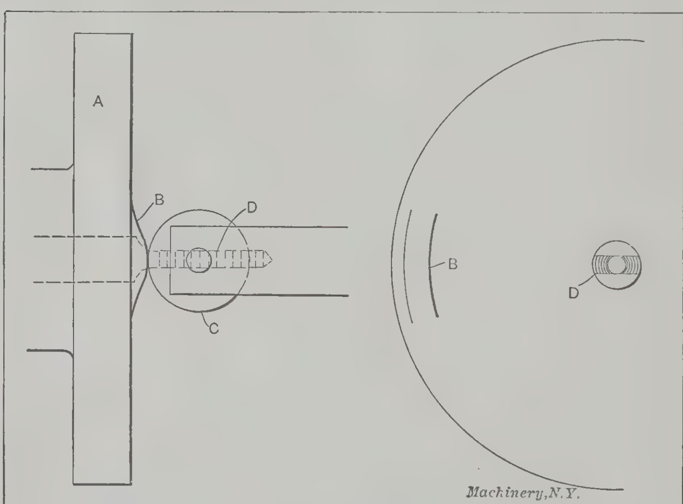


Fig. 2. Diagrammatical View of Special Lathe Attachment used for Backing Off the Reamer Teeth

as there are flutes. I have used this attachment for making forming drills for a large variety of brass cast work and it is the best thing that I know of for backing off cutting edges of tools of this type. JOHN M. FRUIN.

Waterbury, Conn.

DRAWING WITH CROSS-SECTION PAPER UNDER TRACING CLOTH

In the April number of MACHINERY there is a note telling about the use, in England, of tracing cloth with cross-section rulings. As many offices may not find it advisable to obtain a supply of this special cloth the following will doubtless be of interest. Take a sheet of first-class section paper with black ruling and fasten to the drawing board with small tacks. Place the regular tracing cloth over the ruled paper and draw directly on the cloth. In many lines of work it is possible to make the complete drawing in ink without the use of a pencil. I have seen entire switchboards of large size drawn in this manner. When drawing the detail parts such as angle irons, copper bars, rods, etc. (when the dimensions are important and the picture only a place to hang them) the ruled paper beneath the tracing will prove a great time saver. It is, of course, necessary for the draftsman to have his work clearly in mind, or a rough sketch before his eyes. RALPH W. DAVIS.

Rochester, N. Y.

BENDING FORM FOR SPIRAL SCROLLS

While visiting a small railing shop, where considerable scroll work is done, I saw a number of pieces with spiral ends, as shown in Fig. 1, and I could not imagine how they were

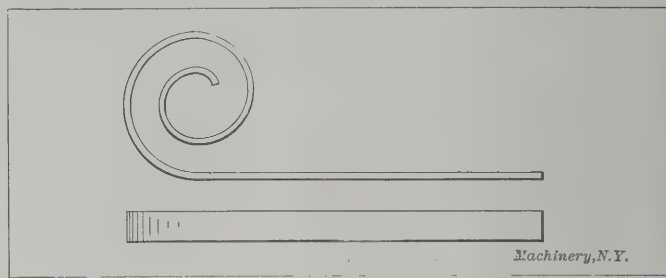


Fig. 1. Scroll which is bent on the Form shown in Fig. 2

bent, as it was a shop without power and equipped only with a few hand tools; yet the scrolls were an example of good workmanship. I began to look around and ask a few questions, when I found that the method of bending these scrolls was "as easy as rolling off a log." A piece of straight, flat stock was heated to a dark red, and then bent on a form, similar to that shown at *A* in Fig. 2, which was held in the vise. The work, after being removed from the form, was

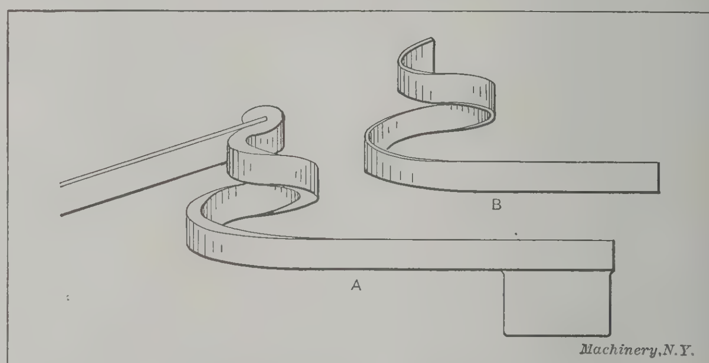


Fig. 2. Bending Form and Shape of Work before it is flattened

then in the shape of a conical spiral, as shown at *B*. In order to form the scroll shown in Fig. 1, the piece was simply flattened down on a straight plate. HERMAN JONSON.

New York City.

* * *

NATIONAL MACHINE TOOL BUILDERS ASSOCIATION CONVENTION

The National Machine Tool Builders' Association held its eighth annual convention at the Hotel Astor, New York, October 12 and 13, with the following official organization: President, Fred L. Eberhardt; first vice-president, C. A. Johnson; second vice-president, E. P. Bullard, Jr.; treasurer, W. P. Davis; and secretary, P. E. Montanus. The list of members including the concern admitted to the association at this meeting follows on the next page.

President Eberhardt in his address referred to the Hudson-Fulton celebration and the great advances in transportation that this celebration commemorated. He referred to the position of the association favoring the reduction of the tariff on the metal-working classifications; and expressed the conviction that the government authorities in Washington—Department of Commerce and Labor—were impressed by the movement initiated in New York last year to bring to their attention the size, importance and needs of the machine tool industry. He expressed confidence in the future of the industry, it being evident that the trade depression has been passed and that good times are in sight. Paul E. Montanus, chairman, presented the report of the committee on standardizing electric motors as applied to machine tools, which was discussed by Mr. Lodge. The report in part was as follows:

"Regarding the maximum speed of motors, both constant and variable, and the peripheral speed of gears, the committee finds quite a diversity of opinion. From the report we find

that for constant-speed work the majority seem to favor 1,200 revolutions per minute on most of the smaller motors, at least up to five horse-power. There was, however, a difference ranging from 900 to 1,800 revolutions per minute. Where rawhide pinion is used it was found that the maximum speed was somewhat higher, but that still 1,200 revolutions per minute was most commonly used. With metal pinions this was somewhat lower.

LIST OF MEMBERS OF THE NATIONAL MACHINE TOOL BUILDERS ASSOCIATION

Allen, Charles G., Co. .... Barre, Mass.
American Tool Works Co. .... Cincinnati, Ohio
Aurora Tool Works .... Aurora, Ind.
Automatic Machine Co. .... Bridgeport, Conn.
Barnes, W. F. & John, Co. .... Rockford, Ill.
Barnes Drill Co. .... Rockford, Ill.
Bath Grinder Co., Inc. .... Fitchburg, Mass.
Baush Machine Tool Co. .... Springfield, Mass.
Besly, Chas. H., & Co. .... Chicago, Ill.
Binsse Machine Co. .... Newark, N. J.
Bradford Machine Tool Co. .... Cincinnati, Ohio
Builders Iron Foundry .... Providence, R. I.
Bullard Machine Tool Co. .... Bridgeport, Conn.
Carter & Hakes Machine Co. .... Winsted, Conn.
Champion Tool Works Co. .... Cincinnati, Ohio
Chandler Planer Co. .... Ayer, Mass.
Cincinnati-Bickford Tool Co. .... Cincinnati, Ohio
Cincinnati Lathe & Tool Co. .... Cincinnati, Ohio
Cincinnati Milling Machine Co. .... Cincinnati, Ohio
Cincinnati Planer Co. .... Cincinnati, Ohio
Cincinnati Shaper Co. .... Cincinnati, Ohio
Colburn Machine Tool Co. .... Franklin, Pa.
Davis, W. P., Machine Co. .... Rochester, N. Y.
Detrick & Harvey Machine Co. .... Baltimore, Md.
Dill, T. C., Machine Co. .... Philadelphia, Pa.
Dreses Machine Tool Co. .... Cincinnati, Ohio
Dwight Slate Machine Co. .... Hartford, Conn.
Fairbanks Co. .... Springfield, Ohio
Fellows Gear Shaper Co. .... Springfield, Vt.
Fifield, G. W. .... Lowell, Mass.
Fitchburg Machine Works .... Fitchburg, Mass.
Flather & Co., Inc. .... Nashua, N. H.
Flather, E. J., Mfg. Co. .... Nashua, N. H.
Flather, Mark, Planer Co. .... Nashua, N. H.
Foote, Burt & Co. .... Cleveland, Ohio
Fosdick Machine Tool Co. .... Cincinnati, Ohio
Fox Machine Co. .... Grand Rapids, Mich.
Gang, Wm. E., & Co. .... Cincinnati, Ohio
Gardam, Wm., & Son .... New York, N. Y.
Gisholt Machine Co. .... Madison, Wis.
Gould & Eberhardt .... Newark, N. J.
Greaves, Klusman & Co. .... Cincinnati, Ohio
Hamilton Machine Tool Co. .... Hamilton, Ohio
Heald Machine Co. .... Worcester, Mass.
Hendey Machine Co. .... Torrington, Conn.
Henry & Wright Mfg. Co. .... Hartford, Conn.
Hilbert Machine Co. .... Cincinnati, Ohio
Hoefer Mfg. Co. .... Freeport, Ill.
Ingersoll Milling Machine Co. .... Rockford, Ill.
International Machine Tool Co. .... Indianapolis, Ind.
Johnson, I. H., Jr., Co., Inc. .... Philadelphia, Pa.
Jones & Lamson Machine Co. .... Springfield, Vt.
Kearney & Trecker Co. .... Milwaukee, Wis.
Kelly, R. A., Co. .... Xenia, Ohio
Kempsmith Mfg. Co. .... Milwaukee, Wis.
Kern Machine Tool Co. .... Cincinnati, Ohio
King Machine Tool Co. .... Cincinnati, Ohio
LeBlond, R. K., Machine Tool Co. .... Cincinnati, Ohio
Lodge & Shipley Machine Tool Co. .... Cincinnati, Ohio
Lucas Machine Tool Co. .... Cleveland, Ohio
Lutter & Gies .... Milwaukee, Wis.
Mechanics Machine Co. .... Rockford, Ill.
Mueller Machine Tool Co. .... Cincinnati, Ohio
National-Acme Mfg. Co. .... Cleveland, Ohio
National Automatic Tool Co.* .... Dayton, Ohio
Newark Gear Cutting Machine Co. .... Newark, N. J.
Niles-Bement-Pond Co. .... New York, N. Y.
Norton Grinding Co. .... Worcester, Mass.
Owen Machine Tool Co. .... Springfield, Ohio
Poole, J. Morton, Co. .... Wilmington, Del.
Powell Tool Co. .... Worcester, Mass.
Prentice Bros. Co. .... Worcester, Mass.
Queen City Machine Tool Co. .... Cincinnati, Ohio
Quincy-Manchester-Sargent Co. .... Plainfield, N. J.
Reed, F. E., Co. .... Worcester, Mass.
Reed, Francis, Co. .... Worcester, Mass.
Rivett Lathe Mfg. Co. .... Brighton, Mass.
Rockford Drilling Machine Co. .... Rockford, Ill.
Rockford Machine Tool Co. .... Rockford, Ill.
Schumacher & Boye .... Cincinnati, Ohio
Seneca Falls Mfg. Co. .... Seneca Falls, N. Y.
Sibley Machine Tool Co. .... South Bend, Ind.
Snyder, J. E., & Co. .... Worcester, Mass.
Springfield Machine Tool Co. .... Springfield, Ohio
Steptoe, John, Shaper Co. .... Cincinnati, Ohio
Stockbridge Machine Tool Co. .... Worcester, Mass.
Von Wyck Machine Tool Co. .... Cincinnati, Ohio
Walcott & Wood Machine Tool Co. .... Jackson, Mich.
Warner & Swasey Co. .... Cleveland, Ohio
Western Machine Tool Works .... Holland, Mich.
Whitcomb-Blaisdell Machine Tool Co. .... Worcester, Mass.
Whitney Mfg. Co. .... Hartford, Conn.
Wilson, W. A., Machine Co. .... Rochester, N. Y.
Windsor Machine Co. .... Windsor, Vt.
Woodward & Powell Planer Co. .... Worcester, Mass.

* Admitted at this meeting.

"It is with respect to the speed of motors and their variations we found the greatest difficulty at the joint meeting with the Electrical Association. The speeds were so arranged and based on the following suggestions: That the starting basis of constant speed of the A. C., 60 cycles be used as the basis of the D. C. constant-speed motors, and also that this be used as a basis for the working out of the variable speed requirements. The speeds suggested are 600, 720, 900, 1,200 and 1,800 revolutions per minute. These figures are not absolutely correct for the above condition, but are approximately close enough for discussion purposes. In all the speed tabulation it is understood that the variation of five per cent up or down can be allowed. The table which we submit below is the first and the basis upon which the two committees are working.

VARIABLE SPEED MOTORS

		Range			
H. P.	Max. Speed	4 to 1	3 to 1	2 to 1	1½ to 1
1	2200	550	740	1,100	1,480
2	2200	550	740	1,100	1,480
1	1800	450	600	900	1,200
2	1800	450	600	900	1,200
3	1800	450	600	900	1,200
5	1800	450	600	900	1,200
7½	1800	450	600	900	1,200
10	1800	450	600	900	1,200
2	1500	375	500	750	1,000
3	1500	375	500	750	1,000
5	1500	375	500	750	1,000
7½	1500	375	500	750	1,000
10	1500	375	500	750	1,000
15	1500	375	500	750	1,000
15	1200	300	400	600	800
20	1200	300	400	600	800
25	1200	300	400	600	800
30	1200	300	400	600	800
20	900	225	300	450	600
25	900	225	300	450	600
30	900	225	300	450	600
40	900	225	300	450	600
30	720	180	240	360	480
40	720	180	240	360	480
50	720	180	240	360	480

"In order to explain this table, we will take the 2-H. P. size. In it we will suggest the maximum speed as 2,200; the 4 to 1 range would therefore be 550 to 2,200; 3 to 1 range, 740 to 2,200; 2 to 1 range, 1,100 to 2,200; 1½ to 1 range, 1,480 to 2,200. This would require four motor frames to carry out this standard. If any manufacturer should decide that 2,200 revolutions is entirely too high, he has the following option:

"If he uses a 2 to 1 motor, he can use a speed variation as low as 500 to 1,100 or 740 to 1,480. If the 3 to 1 is required, he could use 550 to 1,480, or at least that frame. Therefore, it would seem that while the table may be somewhat high, the number of combinations which could be taken therefrom would be sufficient to meet the requirements of nearly every motor manufacturer. In this table he could also take a 2-H. P. motor with maximum speed 1,800 revolutions. With this he could get a 4 to 1 speed variation, 3 to 1, 2 to 1, and 1½ to 1, with maximum speed of 1,800, 1,200, or 900 for a 2 to 1 motor. This is also sufficiently large to meet nearly all requirements."

A paper entitled "The Creation of Machinists" presented anonymously was interesting to the majority of the members of the association inasmuch as it outlined a plan that has been successfully followed by a machine tool builder in Ohio in training young men to become skilled in the operation of machine tools under conditions that differ materially from those ordinarily surrounding the education of apprentices. In an address on the same subject made by E. P. Bullard, Jr., he referred to his experiences with the partial apprenticeship system successfully used in his company, the Bullard Machine Tool Co., for training men of mature years to become skilled machine men. The following papers were also presented:

"Industrial Education—A Source of Supply Increasing the Efficiency of Machinists," by Mr. F. A. Geier, who described the Cincinnati plan, and M. A. Coolidge on the Fitchburg plan. (See another part of this issue for the text of each.) Dr. W. H. Tolman, director of the Museum of Safety and Sanitation, New York, gave his famous stereopticon lecture "The Perils of Peace, or a Safer America." Dr. Tolman's remarks and views strongly impressed the machine tool builders, and when it became known that he had an itinerary that covered the manufacturing districts of the Middle West, arrangements were made by a number of the western leading machine tool builders to accord him a hearty welcome. The concluding paper delivered on the afternoon of Wednesday was "Reinforced Concrete Construction from the Machine Tool Industry Standpoint," by J. P. H. Perry. This paper was illustrated with stereopticon views showing the features of construction details of interest to those contemplating the use of concrete for manufacturing structures.

The following officers were elected: President, F. A. Geier, Cincinnati, Ohio; 1st vice-president, Fred L. Eberhardt, Newark, N. J.; 2nd vice-president, P. E. Montanus, Springfield, Ohio; treasurer, George W. Fifield, Lowell, Mass.; secretary, Charles E. Hildreth, Worcester, Mass. Rochester, N. Y., was chosen as the meeting place for the spring convention next year.

MACHINERY'S SEVENTH ANNUAL OUTING

Following the convention of the National Machine Tool Builders' Association in New York, MACHINERY gave its annual outing October 14 to nearly 500 invited representatives of the machine tool trade and closely allied industries. The steamer *Sagamore*, chartered for the day, was loaded with eatables, drinkables and "smokables" appropriate for the occasion. The party met at the Battery shortly before noon, and with some misgivings on the part of those inclined to be seasick, the steamer started on a course south by southeast through the choppy waters of the upper bay, Narrows and lower bay. After a somewhat windy trip Sandy Hook was sighted and taken by assault, notwithstanding the presence on the dock of Col. Rogers Birnie of the Ordnance Department of the Sandy Hook Proving Ground, Col. H. L. Harris, of the Coast Artillery Corps, and other officers. Yielding gracefully to the inevitable, the officers guided the invading host through a well-equipped machine shop, where the weapons of war are repaired and supplied with missing members, to the proof battery where the big and little machine tool builders were finally gathered together and photographed *en masse* with the result noted in the accompanying illustrations—but "the worst was yet to come."

The party was ordered to climb up on the five concrete parapets back of the proof battery where the big guns are tested, see Fig. 2, and after being cautioned to stop their ears when the whistle sounded, a 12-inch gun was fired with 270 pounds of nitro-cellulose powder. The 12-inch shell was hurled through two sets of vertical wires about 100 feet apart, comprising part of the Le Boulenge chronograph apparatus used for determining the velocity, and far out to sea, where it was seen to ricochet twice before disappearing. Adequate description of the sight and the sensation produced is quite impossible; it must be seen and felt to be appreciated. Following the firing of the 12-inch gun came the firing of a 6-inch gun mounted on a 6-inch disappearing carriage. Two rounds of shrapnel were followed by one common 7-inch steel shell filled with explosive "D" fired into a sand parapet about 500 yards from the proof battery.

Fig. 1. MACHINERY'S Steamer "Sagamore" approaching Sandy Hook

Fig. 3. Machine Tool Builders, Members of the Machine Tool Trade on MACHINERY'S Outing, October 14

The party of visitors then divided into two groups, one

taking the train on the Sandy Hook R. R., the only railroad owned by the U. S. Government, to the spot where the 16-inch gun is located, while the other party inspected the fortification known as Battery Richardson and mortar battery, Battery Granger, and each party in turn visited the objects of interest

Fig. 2. Machine Tool Builders watching the Firing of Big Guns at Sandy Hook Proof Battery from the Concrete Parapets in the Rear

The inspection of the 16-inch gun under the direction of Col. Birnie was made enjoyable especially by his interesting account of the history and construction of the gun, with some remarks on the experiments made with the Gathmann gun, on a nearby armor plate and with a regular 12-inch gun on 5- and 6-inch armor fitted to a section of a battleship's hull. The 16-inch gun, which is the largest in the world, firing a projectile weighing 2,370 pounds with a velocity of 2,300 feet per second, has been discharged about fifteen times. No duplicate has been built and none is likely to be made because the great weight of the gun makes manual operation practically impossible. (See MACHINERY, December, 1903.) The lighter 12-inch, and the 14-inch guns recently authorized can, if necessary, be operated by hand, which is a great advantage, as defects in the operating machinery are likely to develop when the total disability of a gun might mean great disaster. The fortifications, Battery Richardson and Battery Potter, facing the main channel, are built of monolithic concrete behind a bank of sand and are practically invisible from the sea. The guns are mounted on disappearing carriages, and beneath the barbettes are ammunition rooms in which shells and powder are stored. Automatic hoists, driven by electric motors, convey the ammunition to the guns when in action.

The party returned to the Battery about 5:45 o'clock after having spent the afternoon on the desolate strip of sandy land

grouped on the Proof Battery, Sandy Hook. Picture taken just prior to the Firing of the Big Guns

seen by the other. Opportunity was given to a limited number to inspect the workings of the range-finding towers in which the positions and distances of vessels miles out at sea are accurately determined, and from which the angles of elevation are telephoned to the batteries.

near New York that is frequently mentioned in the public press, but on which very few Americans have ever set their feet, it being a government reservation to which admittance is usually denied. The fortifications, of which only a fraction were inspected, are said to be the strongest in the world.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

THE BRYANT CHUCKING GRINDER

A great many interesting machine tools built in the small machine tool manufacturing towns in Vermont have from time to time been illustrated and described in MACHINERY. The latest interesting machine brought out by the machine tool builders in this state, is the Bryant chucking grinder, built by the Bryant Chucking Grinder Co., of Springfield, Vt. The inventor of this machine is Mr. W. L. Bryant, for eight years chief draftsman of the Jones & Lamson Machine Co., of the same town. Its purpose, though perhaps not the full intent of its field, is indicated by its name. The ingenious features of its construction and mechanism will be made manifest as the description proceeds.

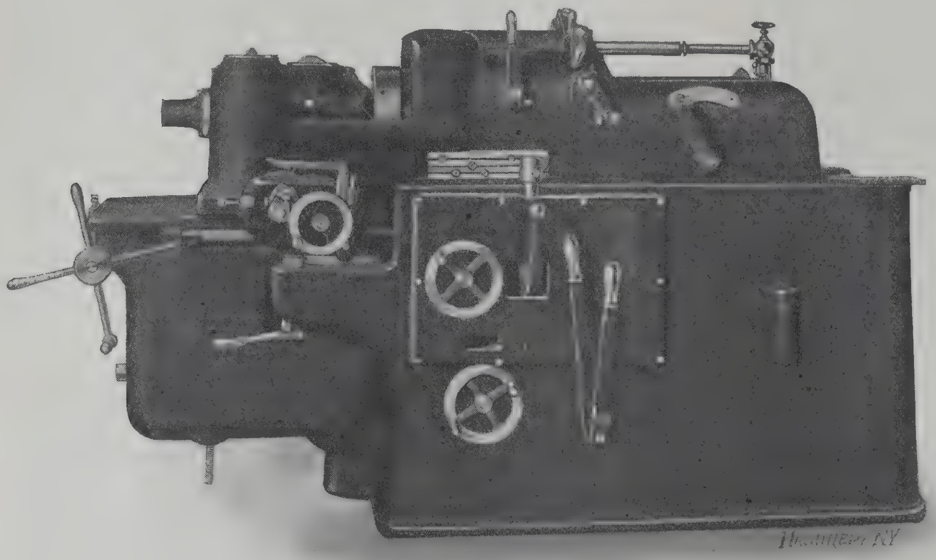


Fig. 1. The Bryant Chucking Grinder, for completing Several Grinding Operations at One Setting

General Description

Briefly, this machine is intended for work held in the chuck, and on such work presents the advantages, first of a number of wheels, constantly set, and each of suitable grain, grade, shape and surface speed for its work; second, of a number of convenient stops, for both longitudinal and cross adjustments, making the accurate duplication of lengths, thicknesses and diameters an easy matter; thus permitting, also, the performing of several operations at one chucking; and, finally, it offers those conveniences of feed and speed change, adjustment and control which make the turret lathe such a profitable investment in a well-managed machine shop.

The general design of the tool will be understood best from a study of Figs. 1 to 4, inclusive. The bed of the machine is a massive casting, *A*, of rigid box form. On its upper surface it is provided with one V and one flat way, on which slides the wheel-carrying head, *B*, carrying three spindles, any one of which may be adjusted outward to permit its wheel to operate on the work without interference from the other two. To the left of the main bed in Figs. 1, 3 and 4, is swiveled the bracket *C*, about the vertical axis of pivot *E*. The angle is read by a graduated circle, and the swivel is brought back to parallel position against a positive stop. Lever L_2 binds this adjustment. This bracket *C*, in turn, supports the work spindle head *D*; the swiveling about the axis of *E* thus gives provision for grinding tapers. A longitudinal adjustment of the head on the bracket, by pilot wheel E_2, against any one of three adjustable stops, permits a change of adjustment to agree with the length of the work projecting from the chuck; a cross adjustment at this point gives control of diameters, and feeds the work across the cup wheel for facing cuts. This cross feed is operated automatically from the power traverse of the wheel spindle head. Having thus briefly described the structure of the tool, we are prepared for a detailed description.

The Wheel and Work-driving Mechanism

The whole machine is driven from a constant speed pulley *F*. No complicated overhead works are required, the machine may be located without strict reference to the countershaft space, and the motor-driving problem is reduced to its simplest terms.

Pulley *F* is keyed to shaft *G*, which, in turn, is keyed to drum *H*. Over the latter passes a belt which runs over a series of tight and loose pulleys (see *J* and J_1) on the wheel spindle driving shafts. These are so arranged that the shifting of the driving belt connecting drum *H* with pulleys *J*, J_1, etc., transmits the power to either the rear, or facing wheel, the center or internal wheel, or the front or external wheel. Lever *K* and belt shifter *L* control the driving belt for this purpose. Drum *H* and shaft *G* are mounted in a swing cradle, to keep the driving belt tight. The adjustment for this cradle is shown at *M* in Fig. 3. It should be noted that the driving belt does not pass directly over the pulleys on internal spindle *N*. Instead, the pulleys on this spindle are driven at an increased speed from pulley Z_1 on the idler shaft. The central position of lever *K* normally stops all the wheel spindles, but by the operation of lever *O*, the internal wheel may be started or stopped.

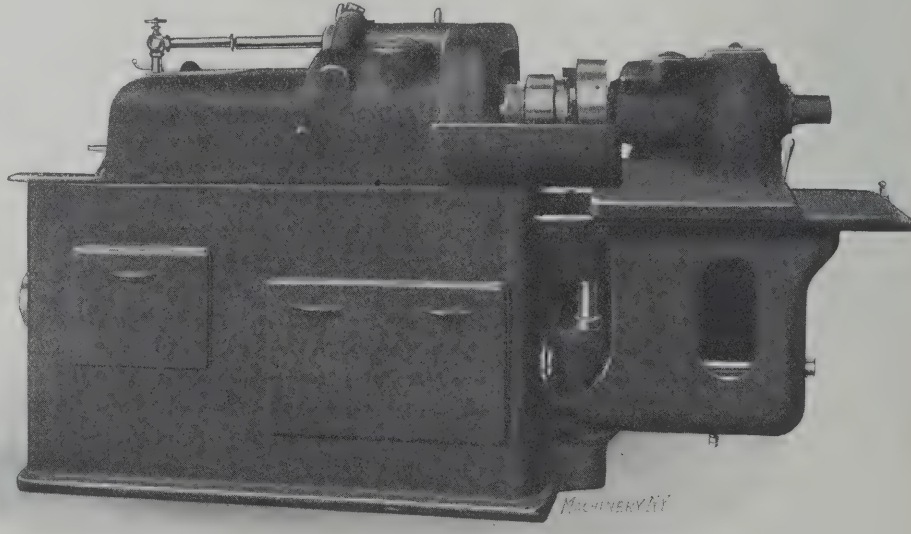


Fig. 2. Rear View of Grinder, showing Massive Construction

Levers *P*, P_1 and P_2 are connected with the wheel spindle quills by a rack and pinion movement, which allows them

to be projected or withdrawn, as required for clearance. These levers are provided with positive adjustable stops for this movement, permitting the duplication of the adjustments on each successive piece of work. Lever Q binds or loosens all the quills simultaneously, for making this adjustment.

in which is journaled a drum, connected by spur gearing with shaft V. From this drum a belt passes around idler X, and over driving pulley Y on the work spindle. A spring Z (see Fig. 3) keeps the drum in the swinging yoke drawn down, so the belt is always taut. Lever A_1 controls a reversing

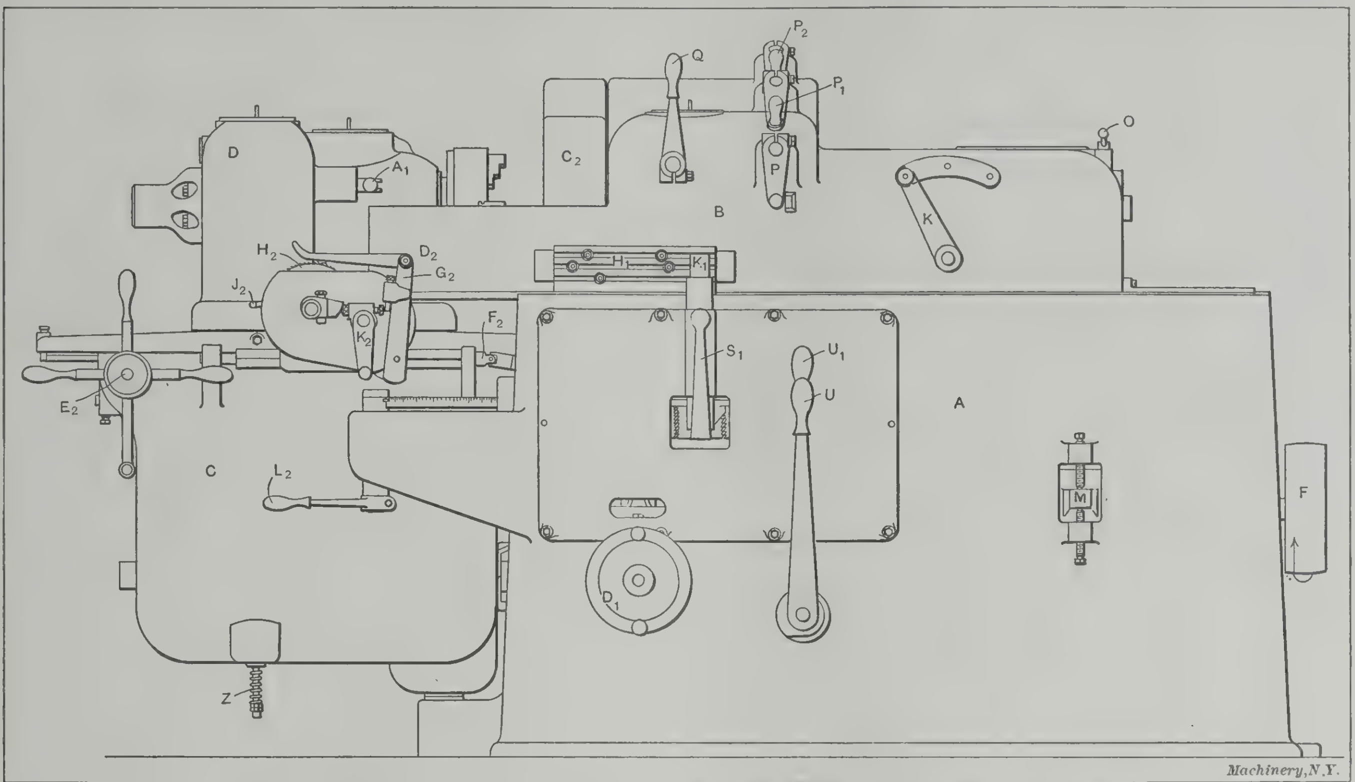


Fig. 3. Front Elevation, showing Arrangement of Slides, Controlling Levers and Hand-wheels, etc.

Shaft G, see Fig. 4, carries also a small pulley R for driving the usual water pump, and also the pinion S, which meshes with the driving gear for the work speed changing mechanism. This latter is mounted as a unit in an oil bath casing, and is of the double clutch, silent ratchet type made familiar in the spindle drive of the Hartness flat turret lathe. It is

mechanism for the work spindle, operating through shaft B_1, and the connecting gearing shown. This is employed for certain cases in which the rear or facing wheel spindle is used for cylindrical or internal surfaces. The same lever A_1 is used for stopping the work spindle, and is connected with a brake for doing this expeditiously.

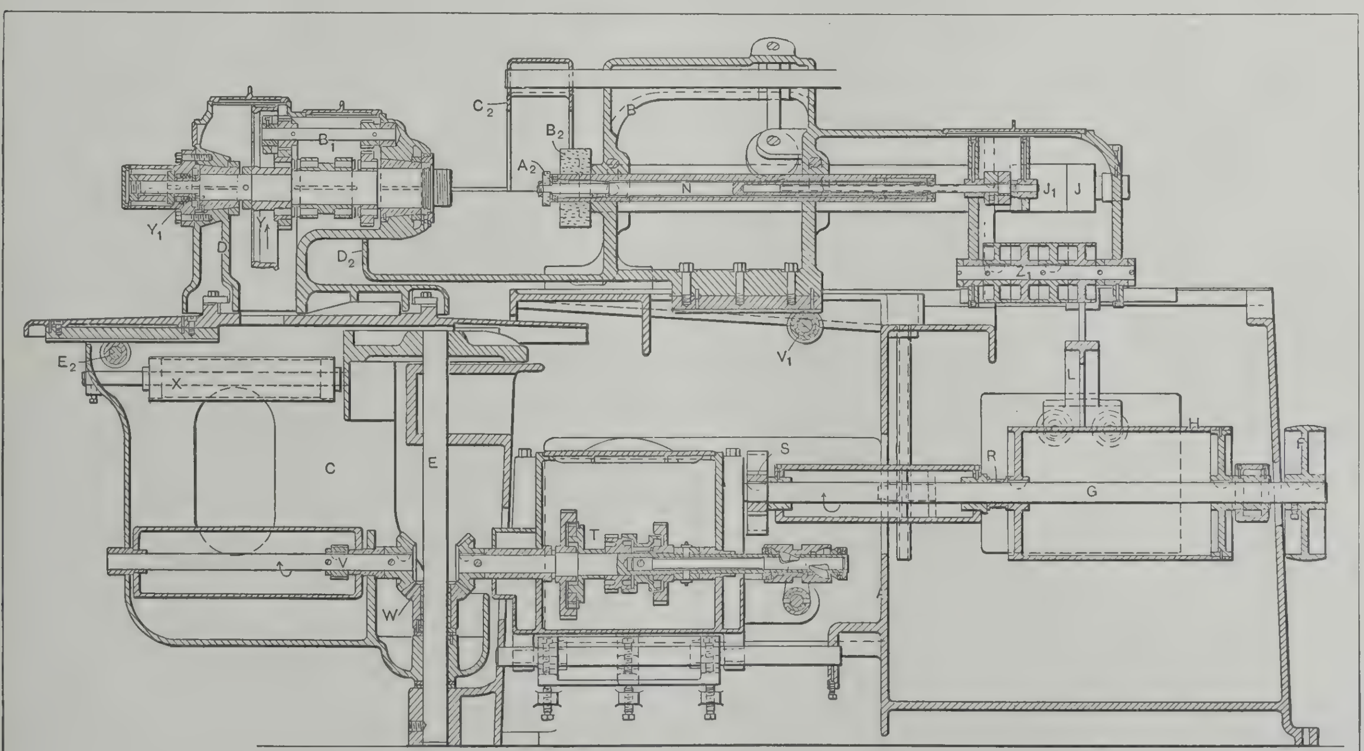


Fig. 4. Longitudinal Section, showing Work and Wheel-driving Mechanism, and General Structure of the Machine

incompletely shown at T, in Fig. 4. The nine changes of speed are controlled by the two levers U and U_1.

From the speed box, the motion is transmitted to shaft V in swiveling bracket C, through the angular bevel gear drive at W, about the axis of E. About shaft V is pivoted a yoke,

The Longitudinal and Cross-feed Mechanisms

The variable feed mechanism for operating the traverse of the wheel spindle head is best seen in Fig. 5. It is connected by a train of gears with the driven shaft of the work speed change mechanism, so that the linear feed of the wheel per

revolution of the work is not affected by changes in work speed. The variation in feed is obtained by the Hartness modification of the Sellers friction disks, in which a very slight swing of the female disks changes the point of contact so rapidly as to effect a great change in the feed. The male or driven disk is shown at C_1, in Fig. 5. The change of feed is effected by a cam connected with hand wheel D_1 in Fig. 3.

Disk C_1 is connected with shaft E_1 by a bevel gear reverse F_1, controlled by the clutches at G_1. At H_1, on the side of the wheel spindle slide are cut three T-slots, in which are clamped

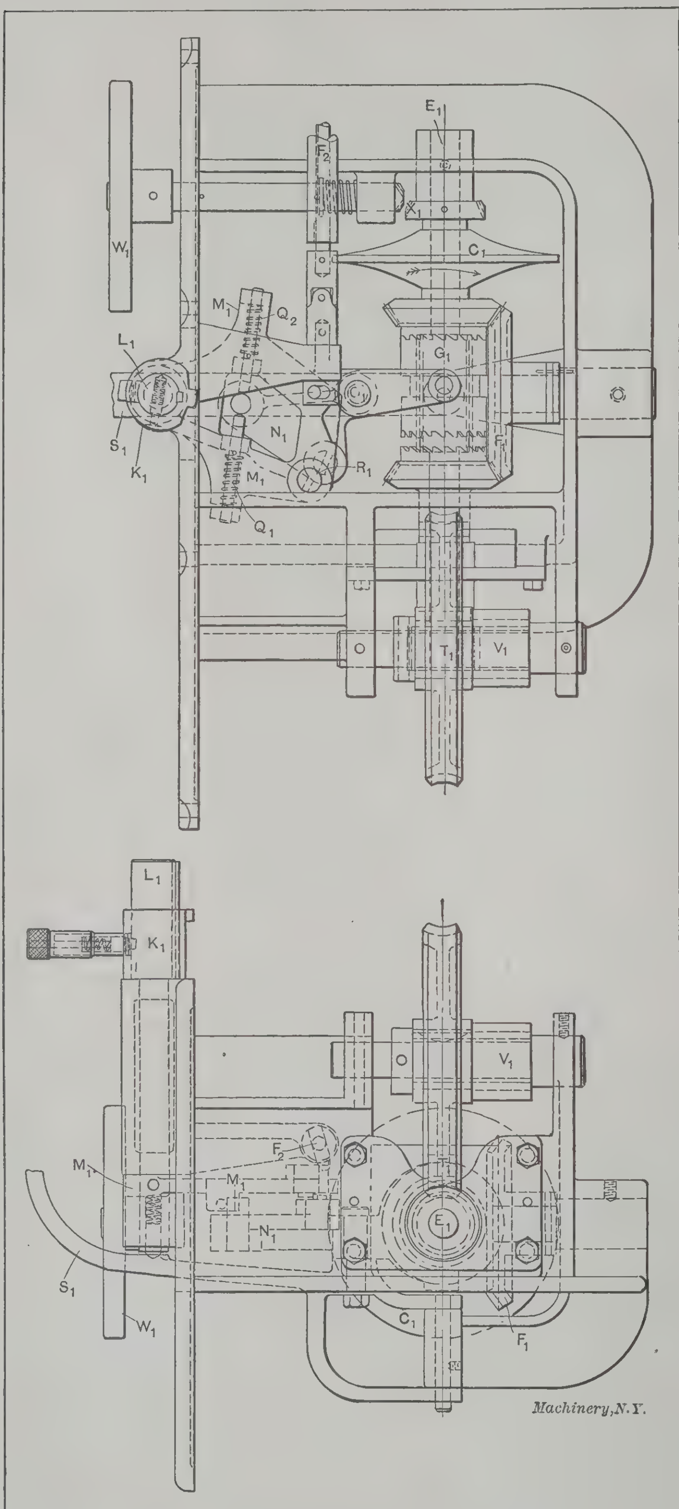


Fig. 5. The Wheel Head Traverse Mechanism

three sets of automatic reverse dogs, one for each wheel. These dogs strike a projection on collar K_1, which may be raised or lowered on rock shaft L_1 to line with the set of dogs it is desired to use. To L_1 is keyed the sector M_1, which is one member of a "load and fire" mechanism for controlling clutch G_1; its purpose is to prevent the clutch from stopping on dead center. It is the simplest in construction of any mechanism of this kind the writer remembers having seen.

Clutch G_1 is shifted to the right or left by a fork and sector N_1, pivoted at O_1. In the position shown, when sector M_1 is swung to the left by the reversing dogs, spring Q_1 is thereby compressed against a pin in sector N_1 tending to throw it to the left, and thus throw the clutch G_1 to the right, reversing the movement. This is prevented for the time being, however, by the interference of the ledges milled in the faces of the pins at R_1, one of these being fast in sector M_1 and the other in N_1. When M_1 has been turned so far to the left, however, that spring Q_1 is properly compressed, these pins snap by each other on the further side, allowing the clutch to be thrown.

Going in the opposite direction, this process is reversed. The dog at H_1 swings sector M_1 to the right, compressing spring Q_1 against the pin in N_1. The swinging of the latter under this spring pressure is resisted as before by the pins R_1, which finally snap by at the end of the movement. The pivot O_1 of segment N_1 is mounted in lever S_1, which thus furnishes means for stopping and starting the traverse movement at any point in the travel, independently of the automatic reverse.

The motion from the reverse clutch at G_1 is transmitted to the wheel spindle head through worm gearing at T_1 and a

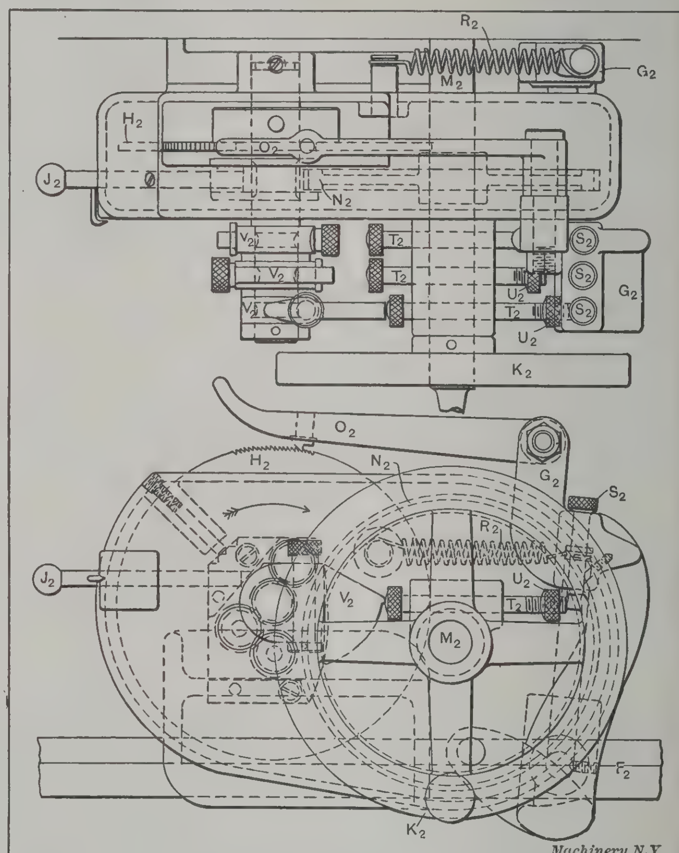


Fig. 6. The Cross-feed Mechanism, with Automatic Diminishing Device and Stop

pinion at V_1, which engages the rack under the slide. Fine hand adjustment for facing, etc., is effected when the power feed is thrown out, by hand wheel W_1, through bevel gears at X_1. This hand wheel is shown in Figs. 1 and 5, but not in Fig. 3, the latter being incomplete in this respect. When not in use, it is withdrawn until bevel gears X_1 are out of engagement, and the wheel is free.

A telescopic shaft, F_2, leads from the automatic traverse mechanism on the main base of the machine, to the cross feed mechanism for the work spindle head on the swiveling bracket. This shaft is rocked at each end of the stroke by a cam surface on sector M_1, which is, as we have seen, controlled by the reversing dogs at H_1. The telescopic shaft transmits this movement properly at whatever angle the swiveling bracket and work spindle may be set.

The cross feed screw M_2 (see Fig. 6) has mounted on it a hand wheel K_2 (a crank is shown in Fig. 3) and a spur gear N_2. This latter is connected with ratchet wheel H_2 by a tumbler gear arrangement, controlled by lever J_2, which thus provides for reversing and throwing out the feeds. The

ratchet wheel is operated by a pawl O_2, pivoted to lever G_2, which in turn receives its movement from rock shaft F_2 shown in Figs. 3 and 5. This movement is positive in the direction which operates the ratchet wheel H_2, and through it the cross feed. In the other direction it is drawn back by spring R_2 until the point of plunger S_2 brings up against the adjustable stop T_2. As the position of T_2 allows a greater or less amplitude of movement to the swinging of lever G_2, a greater or less cross feed is effected at each stroke.

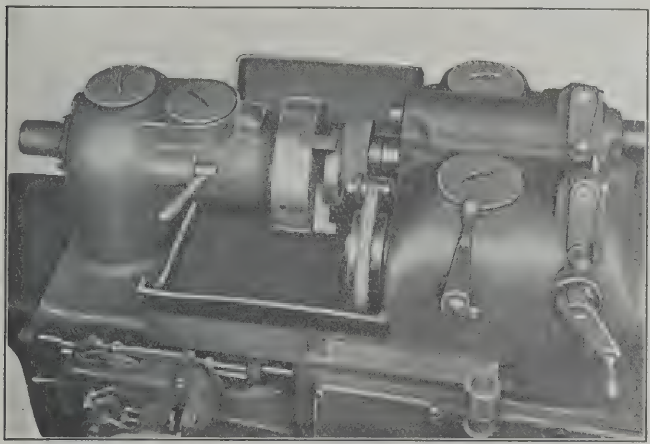


Fig. 7. The Facing Wheel in Use

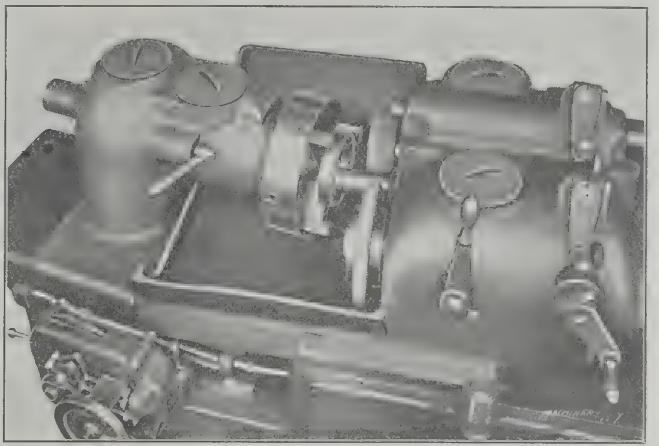


Fig. 8. The Work Head Swivelled for Taper Work

The position of stop T_2, and the consequent amount of feed, is governed by two things. In the first place, the knurled nut U_2 furnishes a check to its backward movement, and thus regulates the rate of cross feed. Screwing this nut out increases the feed—screwing it back decreases it. In the second place, the feed is controlled by cam V_2, which is adjustably clamped on the shaft of ratchet wheel H_2, and revolves with it in the direction of the arrow. As the feeding progresses, the lower edge of V_2 comes into contact with the left-hand end of stop T_2, gradually limiting its movement from that permitted by the adjustment of U_2 until finally, in the position shown, the swinging of lever G_2 is stopped altogether, thus stopping the cross feed. The diminishing depth of cut thus provided for, as the desired finished diameter is approached, gives the best results obtainable from the standpoints of accuracy and finish.

It will be noted in the top view in Fig. 6 that there are three each of stop cams V_2, stops T_2, feed adjusting nuts U_2 and plungers S_2. Any one of these three latter may be pressed down into working position, thus giving a separate cross feed stop and rate of feed for each of three operations.

Salient Points in the Design

The reader might perhaps be pardoned for skipping the detailed description of the mechanism just given. It is made necessary by the fact that the machine is new from "the ground up," so it has to be described in the same way, there being no similar machine with which mental comparisons may be made. The reader, however, should not fail to examine certain noteworthy features of the design which are of universal interest, being applicable to machines of other types, made for other purposes.

One of the points of interest in the machine is its strength and rigidity. This is rather unusual in the matter of weight alone, which is about 4,200 pounds. Rigidity has been secured by very careful design. This might not seem to be important in a grinding machine, where the strains are light as compared with machines of the lathe and miller type. If there are no heavy strains to contend with, however, there is liable to be enough of vibration to cause serious trouble, and weight and stiffness are needed to counteract this.

In the matter of rigidity, note first the heavy box-like form of the main castings. This form also serves, of course, to protect the mechanism from emery dust and other grit. Then again, the solid, long bearing of the swivel adjustment should be compared with that found on the ordinary design of universal grinder. All unnecessary sliding surfaces are

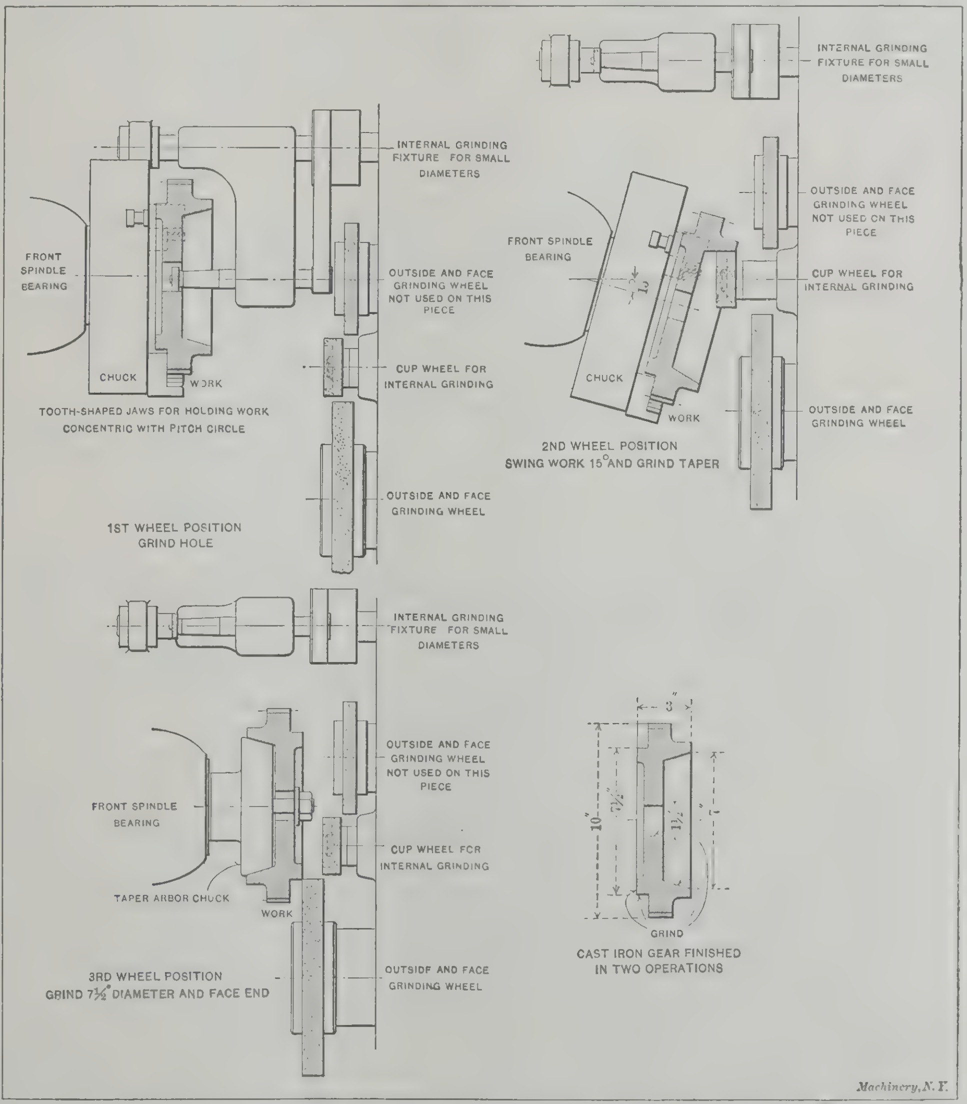


Fig. 9. Diagram showing the Method of Finishing a Hardened Gear with Conical Clutch Surface

avoided, and the connection between the work and the wheel, through the main castings, is strong and direct, there being a notable absence of built-up constructions.

An interesting point, along this line, should be noticed. The work spindle head slides crossways on a thin platen, which, in turn, slides longitudinally on the top of swinging bracket *C*. This platen at first sight appears to be an example of the built-up construction which the designer tried to avoid. This is not the case, however. It is thin and flexible, receiving its stiffness from the head and bracket to which it is gibbed. Furthermore, the gibbing points for this platen on the upper member are directly over those for the lower member, so that strains are transmitted in direct tension and compression, with no possibility of the deflection strains (even in this thin platen) which usually "raise hob" with rigidity.

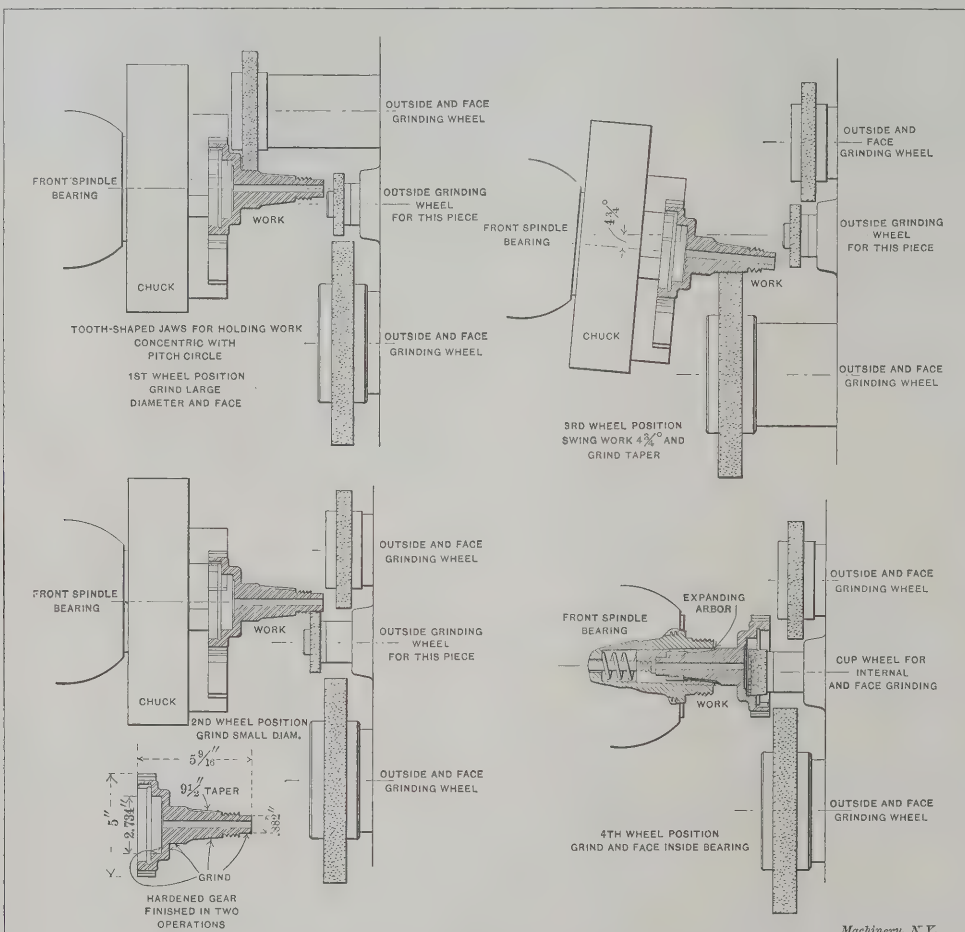


Fig. 10. Method of Finishing a Piece requiring Two Settings, and having Cylindrical, Face and Taper Surfaces to be ground

Criticism might perhaps be directed toward the large overhang of the work spindle. This is given to permit the entrance of guard D_2, to catch the water and dust. This overhang is apparent only, however, as the base of the head is extended to a long bearing out under the working point. It is similar in this respect to the spindle heads used on the Beaman & Smith duplex cylinder boring machines, having the advantage, however, of having the head and extended slide one solid casting, instead of being bolted together, as is necessary in the other case.

Another point shown, though not very plainly, in Fig. 4 at Y_1, is a device used for taking up the end movement of the work spindle. This is very necessary in accurate face plate and chuck work, whether in the lathe or grinding machine, as every good mechanic knows. It is not possible to do it well enough or to do it permanently by adjusting the take-up for the thrust bearing. It is therefore common practice, wherever possible, to put a stick against the center of the work, and bring the tail center up against it, thus taking out the slack. This machine has the stick incorporated in it. Springs at Y_1 are always in action, forcing the spindle up to a firm bearing on the end thrust.

Typical Operations

In Figs. 9 and 10 are shown diagrams which illustrate the use of the machine quite clearly. The first of the parts, in Fig. 9, is a cast iron gear with a conical clutch surface. This has to be ground, as shown, in the bore, the clutch surface, and on one face and outside diameter. In the first operation the work is held by tooth-shaped jaws which hold it concentric with the pitch line. Here the bore is ground with a supplementary internal attachment, as shown, provided for work having small holes. (This supplementary spindle may also be used for buffing and polishing with rouge and a soft wheel.) In the second wheel position the work spindle and the bracket on which it is mounted are swiveled to the angle of the conical surface 15 degrees, as shown, which is finished with the regular internal wheel. For the second operation and third wheel position (which finishes this piece) the work is held by its finished clutch surface on a taper arbor mounted in the work spindle. This arbor may be ground in place to insure absolute accuracy.

The piece of work shown in Fig. 10 is also a gear, but of much more complicated form. It is made of hardened steel. For the first operation (including the first three wheel settings) it is held in gear-tooth chuck jaws the same as in the case shown in Fig. 9. In this first operation all three of the regular wheels are used, all on external surfaces. First the large bearing is ground with the rear wheel, then the small outer bearing is ground with the central wheel, and finally, in the third position, the 9½-degree taper is finished with the outside wheel. This operation shows quite plainly that only a small lateral adjustment of the work spindle is required for the different positions. This will be seen by comparing the center lines of the work and of the central wheel spindle in each case. This is due to the fact that the three wheel spindles are located in this natural position, and to the fact that the swiveling adjustment for taper grinding is about an axis which approximately passes through the point of contact of the wheel and work.

In the fourth wheel position and the second operation, the work is held on the conical shank by a special expanding chuck, made to fit it. For this operation the middle or internal wheel only is used, this being employed for both the grinding of the hole and the facing of its internal seat.

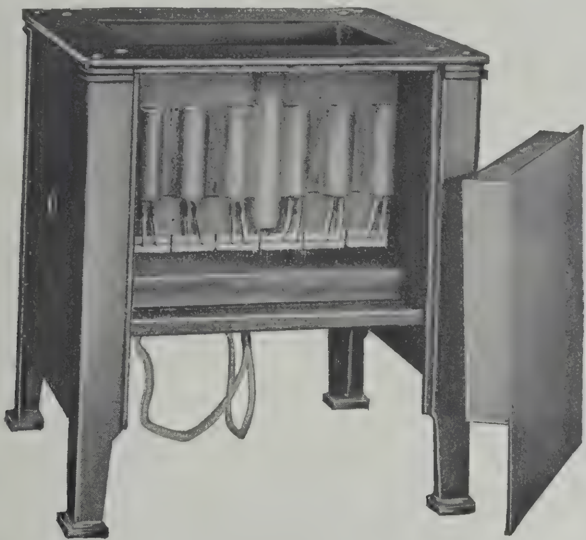
The Field of this Grinding Machine

These two examples will serve to show the convenience and time-saving qualities of this design of grinder, with its three (or four) wheels permanently mounted in place, its variety of adjustments, and its conveniently controlled stops, feeds, speeds, etc., for each operation.

It will readily be seen that this chucking grinder bears the same relation to the standard universal grinding machine, that the turret lathe on chuck work does to the standard engine lathe. Its field is thus a large one, though its particular adaptability to automobile work will be at once recognized. It is entirely conceivable that it may open up a new field of its own, in finishing certain parts from rough turned, or even rough castings and forgings. Mechanics will readily recognize its advantages, as a labor- and time-saving machine, and being, as it is, radically new in its design, it will undoubtedly create considerable interest among machine users.

ELECTRICALLY-HEATED OIL TEMPERING BATH

The accompanying illustration shows an electrically-heated oil tempering bath manufactured by the General Electric Co., Schenectady, N. Y. The bath is contained in a cast iron tank or pot, having 12 lugs evenly spaced around the sides. These lugs are drilled to receive standard cartridge units, and by thus distributing the units an even temperature can be maintained



Electrically-heated Oil Tempering Bath, made by the General Electric Co., Schenectady, N. Y., showing Removable Cartridge Units

in all parts of the oil. Around the pot is placed a heat retaining jacket, consisting of an inner and outer wall of sheet metal, the space of three inches between the walls being filled with mineral wool. The jacketing on the back side of the tank is easily removed, thus allowing quick access to the internal connections of the units. Around the top of the tank a wide flange is provided, to which four cast iron legs are screwed. A drain pipe controlled by a globe valve provides a means for drawing off the oil. A protected recess is provided in one end of the tank in which a thermometer may be placed for indicating the temperature of the oil bath.

Two methods are in vogue for using the oil bath. In the first method the temperature of the oil is raised to 250 degrees F., and then the work is placed in the bath and the full current turned on. When the oil reaches the desired temperature, the work is removed and the current turned off. The second method is to turn on the full heat at once, and bring the oil to the required temperature, and then to introduce the work, and by means of regulating switches, maintain the temperature constant for any required length of time.

A cast iron basket or tray may be supplied in which the work can be placed. This basket has eye-bolts at each end to facilitate its handling, and the bottom is perforated with ⅞-inch holes to permit free circulation of the oil. Short legs are provided on the bottom of the basket which keep the work about an inch above the bottom of the bath.

Any desired temperature is obtained by throwing in the necessary number of units to give the approximate heat. Close regulation is then secured by varying the voltage on one of the units by means of a rheostat. Three sizes of tempering baths are made, the smallest having a capacity of nine gallons of oil, the medium size, of 11 gallons, and the largest, of 37 gallons, the first requiring 6 K. W. per hour, the medium, 7.2, and the largest size, 20 K. W. for its operation. This energy consumption is sufficient to heat the oil to a temperature of 450 degrees F. in less than one hour, when starting cold. The lengths of the three sizes are 22, 18, and 30 inches, respectively; the widths, 12, 12, and 16 inches, and the depths, 8, 12 and 18 inches. The smallest oil bath weighs 420, the medium, 475, and the largest, 900 pounds.

CINCINNATI-BICKFORD 20-INCH GANG DRILL

The accompanying illustrations Figs. 1 and 2 show front and rear views, respectively, of a new arrangement of 20-inch sliding head drills operating in gang, and manufactured by the Cincinnati-Bickford Tool Co., Cincinnati, O. As shown in the illustrations, four individual drills, each fitted with power feed, automatic stop, and quick return, have been placed on a common base pedestal. The rear view, Fig. 2, shows the driving arrangement, transmitting the power through a continuous shaft provided with clutches, admitting of the throwing in and out of any one drill at any time. The continuous shaft is provided with a tight and loose pulley at one end, as shown. The lever for operating the clutches by means of which each spindle can be stopped independently, is bent over towards the front, so that the operator at the front of the machine can conveniently reach it.

These drill presses are provided with sliding heads and the table has also a sliding movement as shown in Fig. 1, so that it can be operated up and down by means of a crank on ways planed on the face of the column, giving the table a rigid support and bearings at points far apart. The arrangement of sliding heads in combination with a vertically movable table gives the machine a considerable range for handling pieces of comparatively large proportions. The table is continuous across the whole front of the machine as shown, and is provided with two T-slots. The sliding heads are balanced

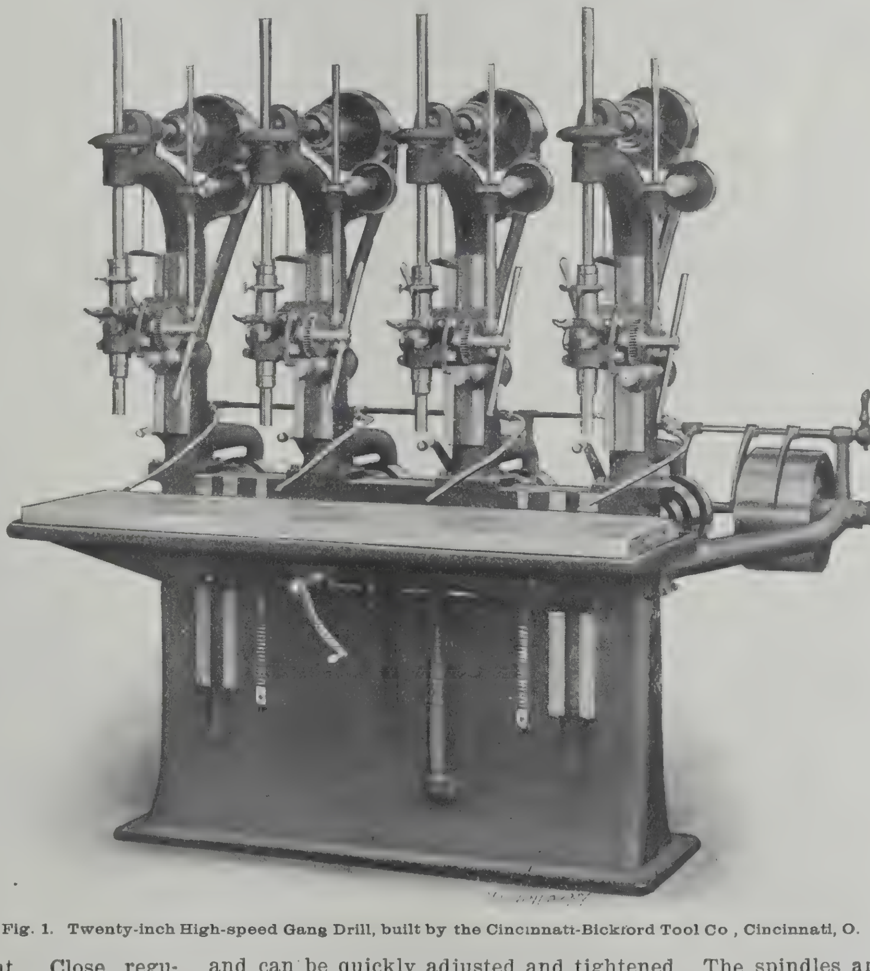


Fig. 1. Twenty-inch High-speed Gang Drill, built by the Cincinnati-Bickford Tool Co , Cincinnati, O.

and can be quickly adjusted and tightened. The spindles are provided with ball thrust bearings, and with steel jam nuts, which minimize the friction and afford adjustment for taking up the wear, when necessary. The sleeves, shafts and spindles are finished by grinding.

Three power feeds are provided for the spindle, the power feed being operated through pulleys, worm and bevel gearing.

The worm operating the worm-wheel on the pinion shaft in the head revolves in an oil bath contained in the worm casing, thus insuring long life to the worm gearing. All the bevel gears are planed so as to provide proper contact between the teeth and silent running. Proper guards are provided for all exposed gearing. The spindle sleeve is graduated, and on the power feed machines provided with automatic trip, this graduation affords a means for setting accurately the automatic trip collar.

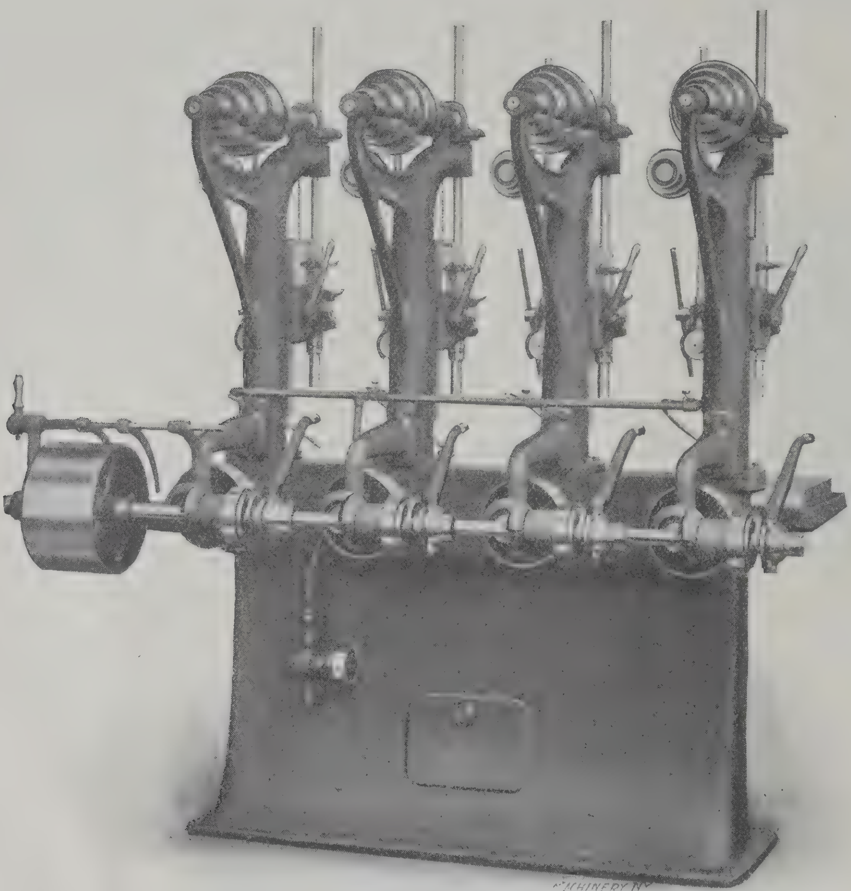


Fig. 2. Rear View of Gang Drill, showing Arrangement for Driving with one Continuous Shaft

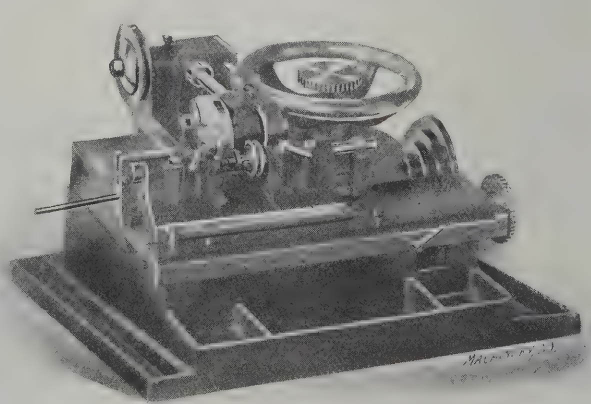
These machines are also furnished without power feed and can be arranged in gangs with any number of spindles from two up. They are also furnished on individual base columns, both with and without power feed construction, and with a variety of tables furnished according to the needs and requirements of the customer. An oil pump and the necessary piping is provided as shown, and a tank or reservoir for the oil is placed within the base.

WALTHAM AUTOMATIC STAFF TURNING MACHINE

The machine shown in the accompanying illustration has recently been brought out by the Waltham Machine Works, Waltham, Mass. It is built for automatically turning several shoulders on small work, such as the staffs of watches clocks, etc., at one setting. The general design of the machine is as follows: Two slides are provided, one of which carries the work supported on dead centers and driven by a dog from a belt-driven plate. The other slide has a motion at right angles to the first, and carries the tool or tools. A vertical shaft at the rear of the machine carries two cams, one for each slide, the cams actuating the slides by means of sliding wedges which are in contact with hardened rolls on the slides. These latter are kept up against the wedges by springs and the wedges are kept in contact with the cams by similar means. The angles of the wedges are such that the longitudinal movement of the wedge transmits a reduced movement of the slides. For watch work the movement of the work slide is made one-quarter, and of the tool slide one-eighth, of the longitudinal travel of the wedge, but for larger work a different reduction may be made. This arrangement is advantageous, inasmuch as it makes it possible to greatly reduce any small inaccuracies in the cams, the rises of which are several times the required travel of the slides.

The head- and tail-stock spindles which carry the dead centers have longitudinal adjustment in their bearings, and are so designed that when the head-stock center is in its proper position, the other can be withdrawn for changing the work, by means of the lever at the left of the tail-stock. In this way staffs can be turned with all the lengths gaged from the same end, thus throwing all of the errors of the blank to the extreme of the other end where they can be easily rectified. The centers are kept in contact with the work by light springs. For watch work and other work where the total length of the blanks is less than three-quarters inch, the head- and tail-stock are made in a single casting so that correct alignment is more easily maintained. For larger work, however, they are made separately adjustable on a bed plate. In both cases a screw adjustment is provided so that a slight swivel motion is possible for bringing the axis of the centers parallel with the work slide.

A worm and worm-gear drives the cam shaft, and a friction clutch connects the gear with the shaft. This clutch, when released, permits the shaft to be turned by the hand-wheel at the top, so as to make it easier to set the tools. The cams can be cut so that the tools will turn either straight or tapered work, or partly straight and partly tapered. A screw adjustment on each side permits the diameter of the most particular part and the distance of the most important shoulder from one of the ends to be obtained very accurately. The other diameters and lengths will be in correct relation, and duplicate parts can be turned as long as the tool retains its cutting edge. For very delicate watch work and also for work where a considerable amount of stock is to be removed, two cuts should be taken over the work. In order to facilitate this operation a two-tool turret has been provided. This turret is automatically indexed on the completion of each cut. The position of one of the tools in the turret is determined by the screw on the slide, but a separate screw adjustment is provided for the other, so as to make it possible to take the



Automatic Staff Turning Machine, built by the Waltham Machine Works, Waltham, Mass.

finishing cut with independent adjustment. With this arrangement only the finishing tool is required to have the keen point necessary for delicate work, and as but a small amount of stock is removed in the finishing cut, the tool will hold its edge for a long time.

The operation of the machine is briefly as follows: The blank is dogged by the operator, who places it between the centers and starts the machine by a foot treadle. The tool follows the course determined by the cams, turning and squaring all the shoulders on one end of the staff. In a sin-

gle-tool machine the tool then returns to its original position, and the machine stops for the insertion of a fresh blank, which has been dogged by the operator while the machine was running. In a two-cut machine the turret is automatically indexed on the return, bringing the finishing tool in position, and the movements are repeated, the machine stopping first after the completion of the finishing cut, but with the turret indexed again and the roughing tool in position for the next blank. With the two-cut, or with the one-cut machine on long work, the operator can take care of two machines. The capacity of the machines when arranged for larger work is up to 2½ inches long between the centers, and up to ½ inch diameter, but the longest total turning is 1½ inch. The base of the machine is 15 inches square, and the weight about 140 pounds. The machine can be made to take either rectangular or circular tools, as required by the user.

KEARNEY & TRECKER UNIVERSAL MILLING ATTACHMENT

The accompanying line engraving Fig. 1 and the half-tones Figs. 2 to 5 show the construction and application of a uni-

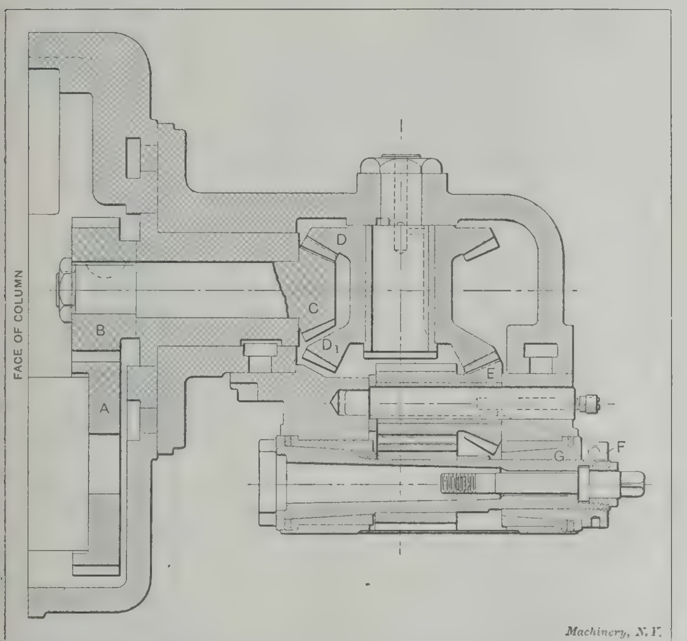


Fig. 1. Section through Universal Milling Attachment made by the Kearney & Trecker Co., Milwaukee, Wis.

versal milling attachment which has recently been brought out by the Kearney & Trecker Co., Milwaukee, Wis. Referring first to the line engraving, Fig. 1, showing a section of the device, it will be seen that the gear A is attached to the regular horizontal spindle of the milling machine, and drives

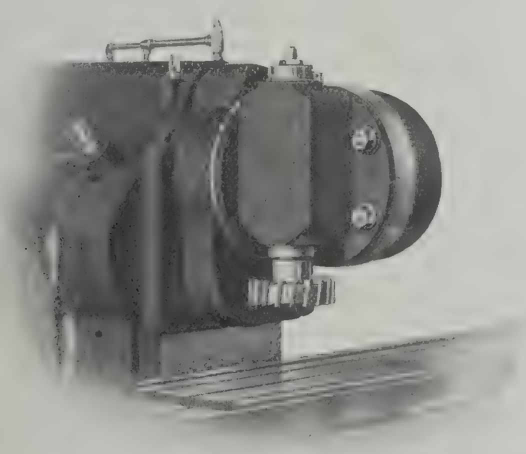


Fig. 2. The Attachment in Position for Vertical Milling

gear B keyed to a horizontal driving shaft on the end of which is cut a bevel pinion C; this pinion drives the bevel gear D, which latter is made in one piece with the bevel gear D_1. This arrangement permits the pinion E to revolve to any position without interfering with the driving pinion C. The bevel pinion E is cut on a steel sleeve on which also are cut spur gear teeth of wide face meshing with a similar gear provided on the cutter spindle of the attachment. All of the gears as well as the cutter spindle are made from hardened steel, the spindle being ground on the outside as well as in the tapered hole.

The wear on the bronze boxes is taken up by an adjustment nut or collar shown at F. The bushing G rotates with

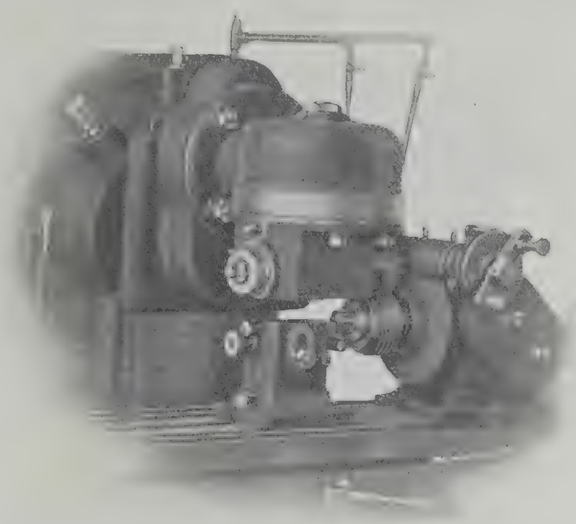


Fig. 3. The Attachment used in Connection with the Spiral Head

the spindle, it being keyed to the latter, although this is not shown in Fig. 1. Thus when the nut F is tightened, this bushing slides forward, and the spindle is at the same time drawn back into the taper box of the front bearing. The end of the spindle is provided with a slot or keyway for driving arbors carrying face mills and large milling cutters in general. The attachment has been made unusually heavy and rigid, and the object in bringing it out has been to provide means for using the milling machine on all kinds of unusual

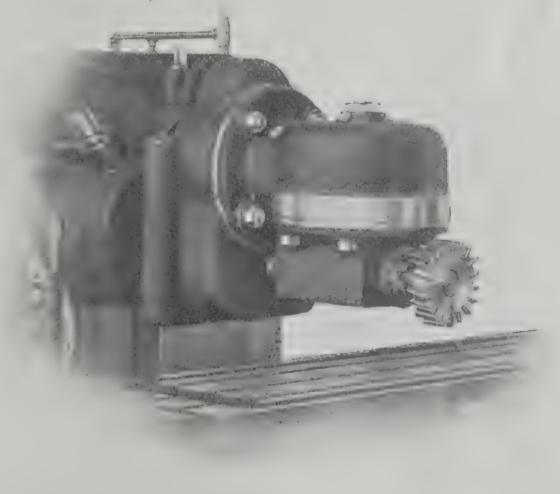


Fig. 4. Using the Attachment for Horizontal Milling at a Slight Angle with the Axis of the Main Spindle

jobs that from time to time arise in every shop, and which the ordinary machines with regular equipment are not sufficient to handle. The attachment will fit all sizes of milling machines built by the makers. It is held in place by being clamped to the knee slide on the column of the machine, the same as the vertical spindle and other attachments of this type, and it can be attached or removed very quickly and without difficulty.

In Fig. 3 the attachment is shown applied to the machine, with its spindle at right angles to the axis of the regular milling machine spindle but parallel with the table. It is here shown operating in connection with the spiral head. In Fig. 2, the attachment is shown in position for vertical milling, and in Fig. 4, for horizontal milling but in a position at a slight angle with the axis of the main spindle. Finally in Fig. 5 it is shown set for angular milling.

This device in connection with the regular horizontal milling machine makes it possible to do all classes of milling on this type of machine, and due to the fact that the attachment has been built along heavy lines, it is possible to perform vertical and angular milling practically to the full capacity of the main spindle of the machine. It has a capacity for face milling with cutters up to 6 inches in diameter. The attachment is made in three different sizes, all being

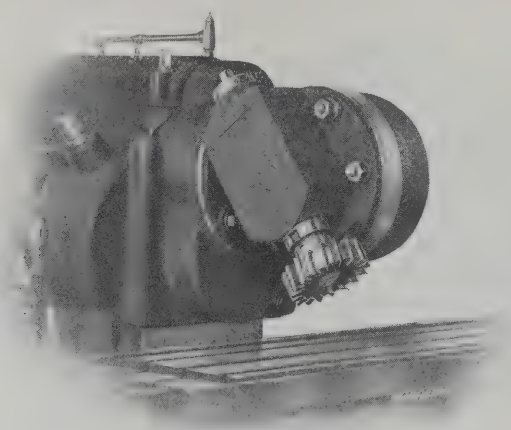
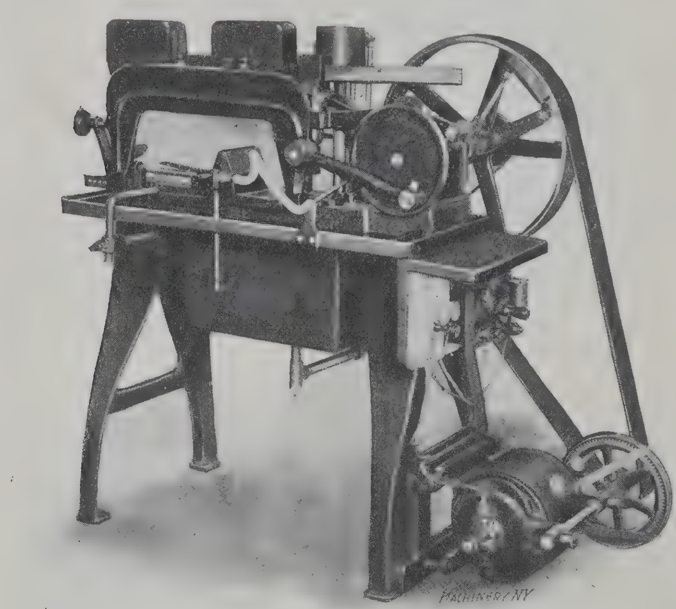


Fig. 5. The Attachment in Position for Angular Milling

provided with No. 10 Brown & Sharpe taper hole in the spindle. The distance from the center of the spindle to the bottom of the attachment does not exceed 1 9/16 inch, and the distances from the center of the spindle to the face of the column when used for vertical milling is 10⅞, 11¼ and 11½ inches, respectively, for the three different sizes. The net weights of the attachments are 265, 290 and 325 pounds, respectively.

RACINE MOTOR-DRIVEN HACK-SAW MACHINE

A hack-saw manufactured by the Racine Gas Engine Co., Racine Junction, Wis., was illustrated and described in the New Machinery and Tools department in the July, 1908, issue of MACHINERY. This machine has now been equipped with direct motor-drive, as shown in the accompanying illustration.



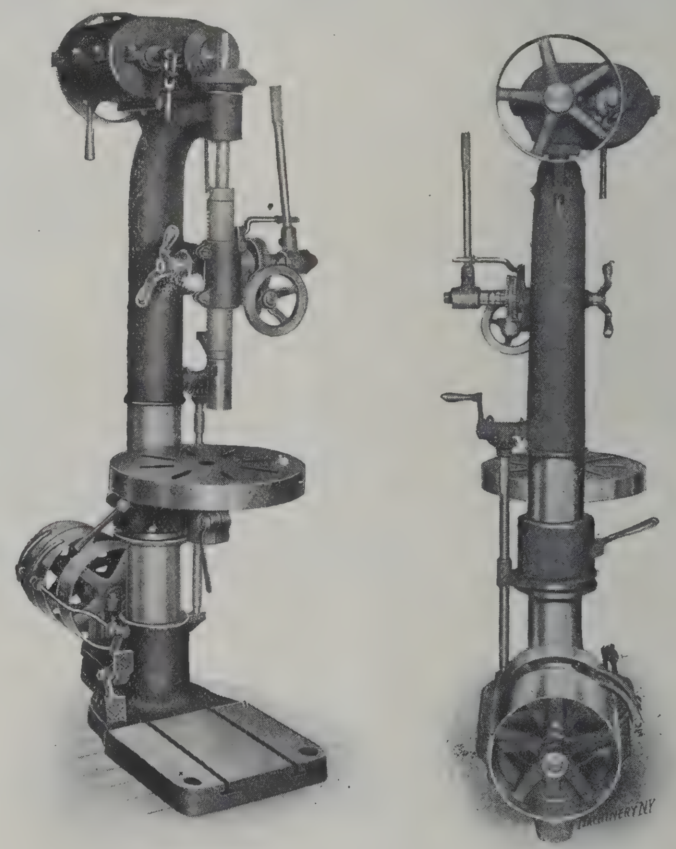
Motor-driven Hack-saw Machine, manufactured by the Racine Gas Engine Co , Racine Junction, Wis.

An important feature in this machine is that means are provided for lifting the saw from contact with the work on the back stroke, thus lengthening the life of the saw and increasing the rapidity of the cutting as well as leaving a smooth surface on the ends of the cut-off work. As will be seen in the illustration the motor is mounted on the lower part of one of the legs of the machine, reduction gearing being provided, and a belt transmitting the motion from the small lower pulley to the large driving pulley. As examples of the capacity of the machine it may be mentioned that a 1½-inch round cold-rolled steel bar can be cut off in 1½ minute, using common hack saw blades, no special blade being required in the machine. Another example of the capacity is that a 70-pound steel rail can be cut off in six minutes.

A special arrangement has been introduced for lubricating the saw while cutting. As seen in the illustration, a rubber hose connects a pipe to the right, which is fed directly from the oil pump, with an adjustable spout over the saw. As will be seen, this spout is mounted on the top of a rod which passes through the side of the bed and is held in position by means of a thumb screw. At the top of the rod a bracket is provided so that the spout can be swiveled about it. This combination makes it possible to raise or lower the spout as well as turn it to any position required.

SIBLEY HIGH-SPEED DRILL PRESS

The accompanying illustrations show a front and rear view of a high-speed drill press recently brought out by the Sibley Machine Tool Co., South Bend, Ind. It has been designed es-



Figs. 1 and 2. Front and Rear Views of 24-inch Drill Press, built by the Sibley Machine Tool Co., South Bend, Ind.

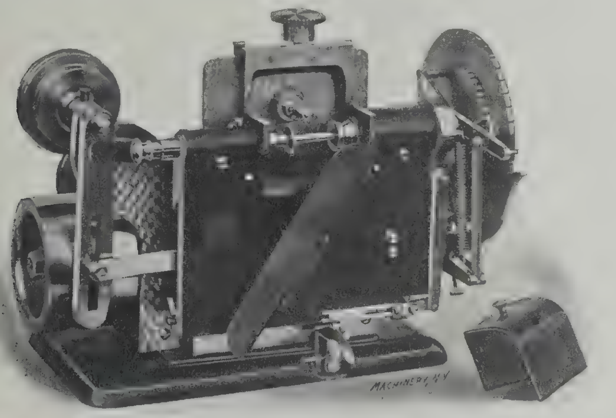
pecially with the view of meeting the demands of the automobile trade, and is provided with some features, new in upright drills, the most prominent of which is the location of the change gear box, which is placed on the top of the column, thus eliminating cone pulleys entirely, the drive being by means of a single constant-speed pulley. The gear box permits of eight changes of speed, and the construction is such that any speed can be thrown in instantly while the machine is running. The change speed gears in the gear box run in oil. The machine shown in the illustration is provided with combined hand-wheel and lever feed, but the machine is also made with geared power feed, if desired. The spindle is fitted with a hole for No. 4 Morse taper, and is provided with ball thrust end bearings. All running bearings are made of bronze. The machine has ample power to run high-speed steel drills of 1½ inch diameter up to the limit of their capacity.

WALTHAM AUTOMATIC GEAR-CUTTING MACHINE

In the June, 1908, issue of MACHINERY an automatic precision gear cutting machine built by the Waltham Machine Works, Waltham, Mass., was illustrated and described. The

accompanying engraving shows an improved design of this machine, differing from the one previously described in many important details. The machine is especially well adapted for cutting brass gears on account of the complete protection from chips provided for the indexing mechanism, the cams and the slides; but it is also suitable for other work and will cut steel gears and pinions of fine pitches satisfactorily. The protection for the working mechanism is obtained by means of a plate attached to the cutter slide and held in contact with the back side of the hood on the work slide. A removable cover also completely encloses the work and cutter, except for an opening below the work through which the chips fall.

During the return of the work slide, after the cut is taken, the cutter is lifted from the work so that the indexing can take place on the return stroke without loss of time. The location of the work slide in relation to the cutter can be adjusted laterally, and the depth of the cut is adjusted by a small handwheel, provided with graduations, at the top of the cutter slide. A large index plate is provided so as to insure accuracy of the divisions, and the different divisions are obtained by the adjustment of a single screw.



Automatic Gear-cutting Machine for Small Work, built by the Waltham Machine Works, Waltham, Mass.

With a "one-cut" machine, *i. e.*, a machine intended to cut to full depth at once, the feeding of the slides and the indexing of the work is continued automatically until all the teeth have been cut, and then the machine stops. With a "two-cut" machine, after the completion of one revolution of the work, the cutter is fed downwards a little deeper for a finishing cut, and the operations are continued another cycle, the machine stopping first after the completion of the second revolution of the work. This feature is of great value when cutting fine pitch teeth or very smooth work, as a finishing cut can, in this way, be made automatically without the attention of the operator.

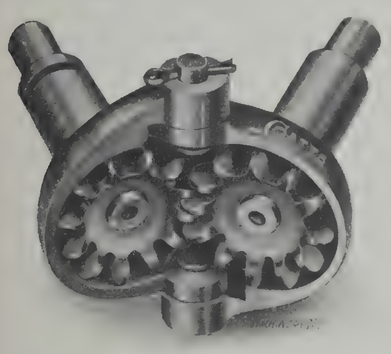


Fig. 1. Universal Coupling Drive operating at any Angle, made by the Coates Clipper Mfg. Co.' Worcester, Mass.

Two sizes of this machine are made; the smaller size is adapted for work up to 1¼-inch diameter, 32 diametral pitch in brass, and 48 diametral pitch in steel. The longest stroke of the work slide in this machine is 1⅜ inch. The base of the machine is 9½ x 12½ inches, and the weight is 115 pounds. The larger machine cuts up to 3 inches diameter, 24 diametral pitch in brass and 32 diametral pitch in steel, the longest stroke of this machine being 3 inches. The size of the base is 11½ x 19½ inches and the weight 285 pounds. If required, a pump and a pan base will be provided for steel work.

COATES MONGREL GEAR UNIVERSAL COUPLING DRIVE

The problem of a satisfactory universal joint, which will work well and transmit power without excessive losses, whether the two shafts to be connected are entirely in line or at a very acute angle with each other, has always been an interesting one to machine designers. A great many universal joints have been brought out which will work very satisfactorily as long as the angles between the two shafts connected do not become too great; but few universal drives will work well when the angle of deviation of the axis of one shaft to the axis of the other becomes more than 45 degrees. The accompanying illustrations, therefore, of the Coates mongrel gear universal coupling drive, will be of particular interest.

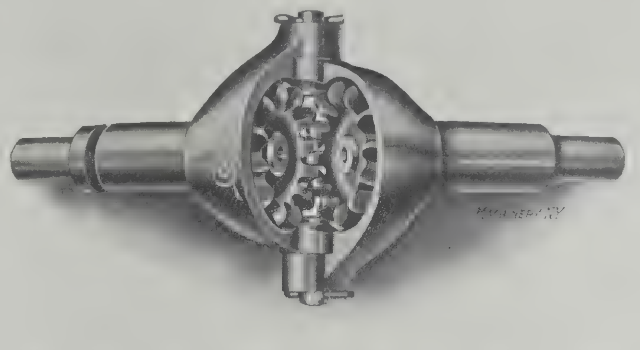


Fig. 2. The Universal Coupling in a position where the Two Shafts are more nearly in Line than in Fig. 1

This device is manufactured by the Coates Clipper Mfg. Co., Worcester, Mass., and its construction makes it possible to transmit power between two shafts either when they are practically parallel, or at a very acute angle as in Fig. 1, or when more nearly in line as in Fig. 2. When the two shafts are entirely in line, as in Fig. 3, the joint becomes practically a positive coupling, while in Figs. 1 and 2 the action is that of bevel gearing, the teeth cut on the parts keyed to the ends of each of the two shafts engaging with each other. The action and construction of the device is very plainly seen from the illustrations and there is little to be said in this respect. The cutting of the teeth in the gears is an interesting operation, and may deserve brief mention. The teeth are cut automatically on one of the Standard Mfg. Co.'s automatic gear cutting machines, shown in the May, 1906, issue of Machinery. This machine is provided with special cams so that the peculiar form in the bottom of the teeth which is not a straight line but a convex curve may be obtained while the cutter passes once across the work. By means of this machine it is possible to, automatically, first feed the cutter forward and then downward, thus obtaining the required shape of tooth.

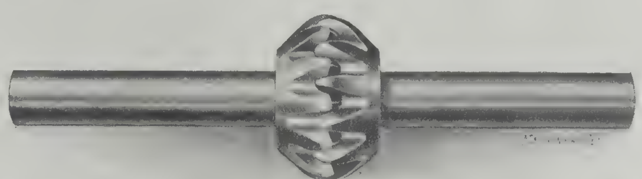


Fig. 3. The Mongrel Gear used as a Postive Coupling

Owing to its peculiar construction and the possibilities of drive which present themselves in this device, it will undoubtedly be of interest to mechanical men, as it is possible by means of this combination to use angular drives that would be difficult or impossible for regular universal joints or couplings.

DRAFTING TABLE

A new type of draftsman's table has recently been added to the line of drawing-room appliances manufactured by the Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass. The particular features of the table are the means for vertical adjustment, and the fact that the table or drawing board proper can be tilted to any angle desired. The top is made of well-seasoned white pine and is cleated to prevent warping, the cleats being so arranged that the shrinkage and expansion are taken care of. Universal drafting machines and parallel rules may be applied to the board if desired.

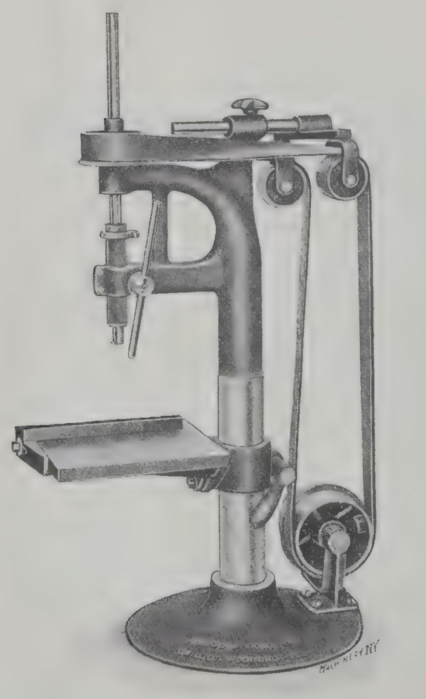
On the under side of the table two cast iron brackets are fastened, these brackets swiveling on the ends of the upright spindles. These swivels are clamped by two nuts operated by means of the small hand-wheel shown on the right-hand side directly below the board. The raising and lowering of the table top is accomplished by the hand-wheel shown near the right-hand upright. Two pinions meshing into racks set into

Draftsman's Table, built by the Washburn Shops of the Worcester Polytechnic Institute

the spindles are keyed to the hand-wheel rod. The raising and lowering feature is rather unique in that the spindles are always automatically locked in position and yet by simply turning the hand wheel in either direction the locking arrangement is released and the top is raised or lowered. The locking device is simple and requires no adjustment, and it has been shown by actual tests that it will stand 1,300 pounds pressure before slipping.

ROCKFORD TEN-INCH BENCH DRILL

The 10-inch sensitive bench drill illustrated in the accompanying half-tone engraving is manufactured by the Rockford Lathe & Drill Co., Rockford, Ill., formerly Rockford Machine & Shuttle Co. The countershaft for this drill can be placed either on the wall or on the ceiling, the driving cone being placed on the base of the machine to prevent vibrations. The driving belt from the pulley at the base to the pulley on the spindle passes over two idler pulleys. These are mounted in an adjustable bracket, so that by means of this adjustment the belt can be tightened as required. The table of the machine can be swung around the column, and can also be tilted to any position, making it very convenient in drilling angular and irregular work. A supporting bracket, as shown in the illustration, is provided, which can be placed on the table when drilling holes at an angle, for supporting the work and preventing it from slipping. The bracket can also be used for preventing work being drilled from revolving.

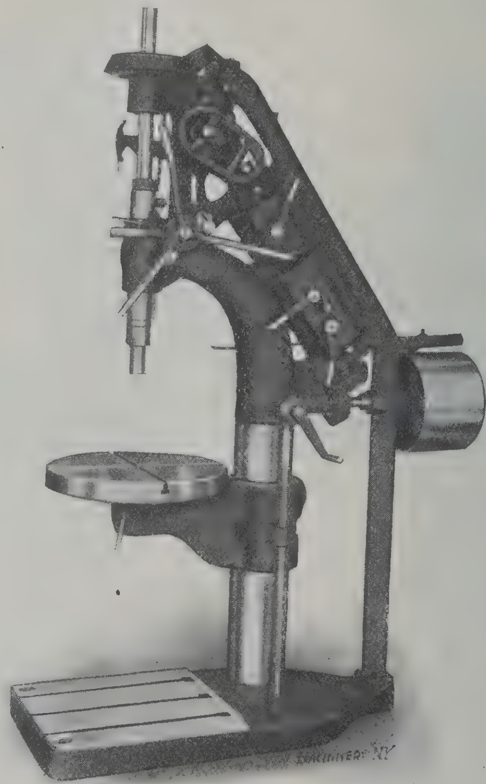


Ten-inch Bench Drill, made by the Rockford Lathe and Drill Co., Rockford, Ill.

The spindle is ¾ inch in diameter, its length being 17 inches. The lever feed of the spindle is 3 inches, and the vertical adjustment of the table 7¼ inches, the greatest distance from the spindle to the table being 10⅜ inches. The table is square, 8 × 8 inches. The driving pulley on the countershaft is 5 inches in diameter for a 1½-inch belt, and the speed of the countershaft is 550 revolutions per minute. The weight of the machine is 112 pounds.

BARNES 24-INCH UPRIGHT DRILL

The 24-inch upright drill illustrated herewith, has recently been brought out by the Barnes Drill Co., 602 S. Main St., Rockford, Ill. This machine is of the same general design as the 20-inch upright drill which was illustrated and described in the May, 1908, issue of MACHINERY, and which has now been on the market for more than one year, during which time it has proved exceptionally satisfactory. The 24-inch drill, while of the same general appearance is, of course, stronger and more powerful. It is of the all-geared type, and is capable of handling as heavy work as the ordinary belt-driven 28-inch drill. The machine has 20 changes of positive power feeds, ranging from 0.0015 to 0.031 inch. All the feed changes can be made instantly by the operator from his position in the front of the drill, without stopping the machine.



Twenty-four-inch Upright Drill, built by the Barnes Drill Co., Rockford, Ill.

The speed changes, including the throwing in and out of the back-gears, can also be made when the machine is running.

The capacity of the drill is up to 2-inch high-speed steel drills, drilling steel. As an example of the power of the machine it may be mentioned that a 2 9/32-inch hole has been drilled in one minute with ordinary carbon steel drills through 2 inches of cast iron at the highest back-geared speed (64 revolutions per minute), or at a feed of 0.031 inch per revolution. In another case a 1 29/32-inch carbon steel drill was pushed through steel 1 inch thick in 55 seconds at a speed of 100 revolutions per minute and a feed of 0.011 inch per revolution. This, in fact, was all that the carbon steel drill could stand. With a 1-inch high-speed steel drill, the machine will drill through 1½ inch in steel in 23 seconds without the back-gears, at a speed of 258 revolutions per minute.

The machine is regularly furnished with back-gears and positive power feed box, but if desired, it can be supplied without the back-gears and the power feed. The machine can also be supplied with back-gears, but without power feed. The table of the machine is provided with T-slots as shown in the engraving, or elongated holes or slots through it, as required. When an oil pump is provided with the machine, it is furnished with a square table, having an oil channel around the edges.

The total height of the drill is 78 inches. The distance from the column to the center of the table is 12¼ inches. The maximum distance from the spindle to the table is 30 inches, and the maximum distance from the spindle to the base is 44½ inches. The diameter of the table is 20 inches, and the diameter of the spindle is 1¾ inch. The spindle is provided with a No. 4 Morse taper hole. The vertical travel of the spindle is 14 inches and of the table 19¾ inches. The ratio of the back gears is 4 to 1. The driving pulley, which is 12 inches in diameter by 4 inches wide, should run at 325 revolutions per minute. The floor space, exclusive of the tight and loose pulleys, which overhang 10½ inches, is 44 by 20 inches. The net weight of the machine complete is 1080 pounds.

LANGELIER SIX-SPINDLE GANG DRILL

The accompanying half-tone illustrations, Figs. 1 and 2, show a front and rear view, respectively, of a sensitive six-spindle gang drill recently brought out by the Langelier Mfg. Co., Providence, R. I. This machine embodies some rather interesting features, the principal one of which is that any of the drill spindles may be brought down independently by operating the foot lever shown in Fig. 1. The machine is not intended for work requiring the drilling of six holes at once, but the object of the machine is to perform six drilling, tapping or reaming operations when they occur in the same piece of work; each spindle performs one operation and the jig or work is passed from one spindle to the other, successively. In a machine of this type it is evidently desirable that all the spindles be brought as close to each other as possible, so that the operator sitting in front of the machine can perform the work without moving from his seat. In order to make this possible, however, it is necessary for each of the spindles to be brought down independently of the others when it is performing its work, so that there is no interference between the other spindles and the jig or the work. This is accomplished by operating the foot lever which actuates the feed for each spindle separately in rotation.

Fig. 1. Six-spindle Sensitive Gang Drill, built by the Langelier Mfg. Co., Providence, R. I.

The connection between the foot lever and the spindles consists of a segment gear which meshes with a ratchet gear on the cam shaft, shown in the rear part of the machine. On this cam shaft is mounted a feed cam for each spindle, these cams being adjustable so that the feed of the spindle can be actuated in any desired manner. The ratchet arrangement prevents the cams from returning to their original position when the pressure on the lever is released so that in this manner one spindle after the other is successively brought into operation by the foot lever. Each spindle has also a hand feed acting independently of the foot feed and an adjustable stop is provided for regulating the depth of holes when drilling.

The spindles are fitted with No. 11 Skinner chucks and are capable of drilling 3/16-inch holes in steel. The vertical feed of the spindles is 2¼ inches. The distance from center to center of the spindles is 3¼ inches. The table of the machine has a working surface of 8 x 28 inches, and is adjustable vertically 4½ inches. The greatest distance from the end of the chucks to the lowest position of the table is 7 inches. The tight and loose pulleys on the countershaft are 5 inches in diameter for 2-inch belt, the countershaft running at 200 revolutions per minute. These machines may be made in gangs with any number of spindles from two up to six, inclusive, and the distance between the centers of the spindles can be made to suit the requirements of the customer.

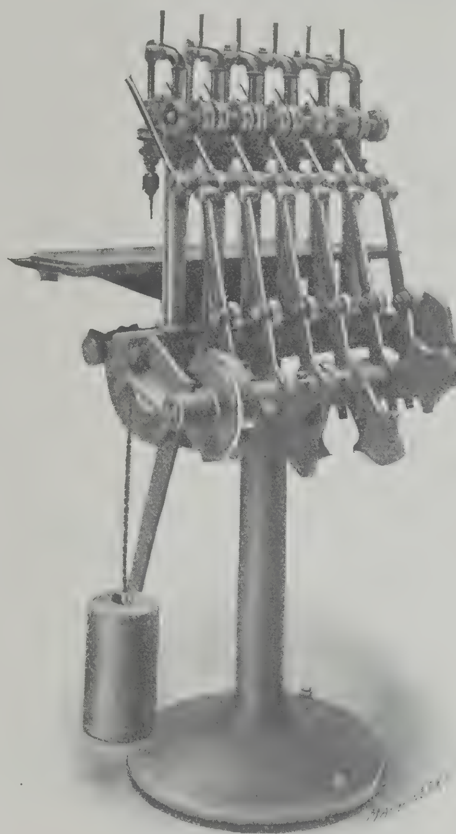
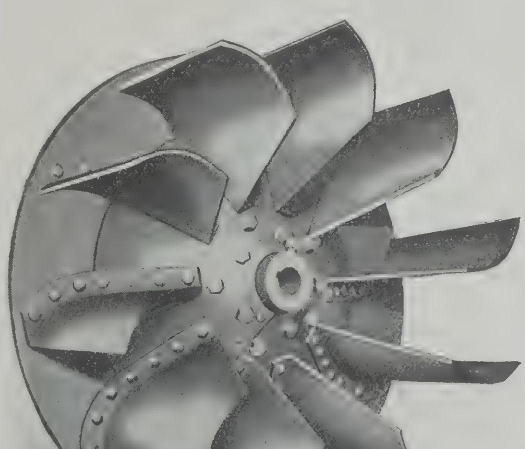


Fig. 2. Rear View of Gang Drill, showing Cam-shaft and Cams for actuating each Drill Spindle independently

BUFFALO SLOW-SPEED EXHAUST FAN

A slow speed exhaust fan, designed particularly with a view of reducing the power consumed for driving, has recently been brought out by the Buffalo Forge Co., Buffalo, N. Y. The fan is known as the Buffalo slow speed low power exhaust fan, and runs at a 20 per cent lower speed than standard exhausters of the same size. It will, however, perform the same work as the standard fans with a 10 per cent reduc-



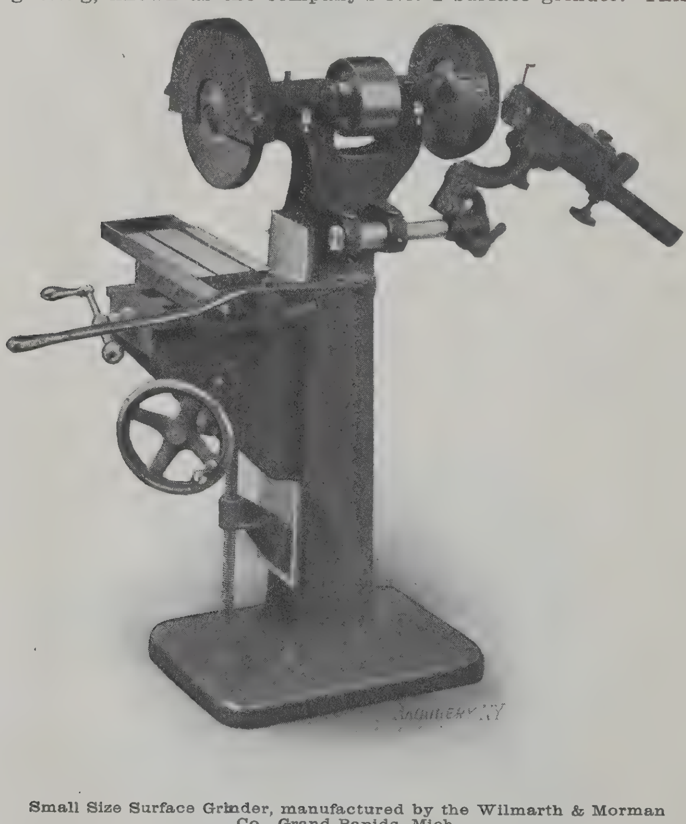
Slow-speed, Low-power Exhaust Fan, made by the Buffalo Forge Co., Buffalo, N. Y.

tion in power consumption. The blast wheel is built of heavy steel plate and instead of the spider usually employed for supporting the vanes, a steel plate cone is used. The apex of this cone is at the inlet of the fan so that the material to be exhausted, when entering the fan, strikes the cone, the direction of the material being gradually changed in this way without the loss of momentum due to sudden changes in direction. The cone offers no obstruction to the free passage of the material. The vanes are securely riveted to the cone and also to a heavy steel plate flange at the side opposite the inlet. This flange is extended beyond the tip of the vanes, preventing any material, thrown from the vanes, from coming in contact with a dead surface and retarding the progress. The fan is overhung on a shaft running in long journal bearings of the double ring oiling type. These bearings are supported on heavy cast iron pedestals in such a manner that the alignment of the fan is constantly maintained. The housing is built of heavy steel plate, securely bolted to a steel frame. It is adjustable to any angle of discharge on either side. All the necessary adjustments are quickly made on the outside of the housing. To change the direction of the discharge the bolts in the ring of each pedestal are loosened, and then the housing is revolved to the desired position.

These exhausters are applicable to various purposes, such as the removal of shavings, sawdust, refuse from wood-working machines and from buff and emery wheels, and from other abrasive processes. They can, of course, also be used for the exhaust of gases, acid fumes, etc.

WILMARTH & MORMAN SURFACE GRINDER

In order to meet the demand for a small convenient surface grinding machine of moderate capacity at a reasonable price, the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has placed on the market the machine shown in the engraving, known as the company's No. 1 surface grinder. This



Small Size Surface Grinder, manufactured by the Wilmarth & Morman Co., Grand Rapids, Mich.

machine has been built with a view of producing a machine equal in accuracy to larger machines, but limited to smaller work. The working surface of the table is 6 inches wide by 12 inches long, and sufficient movement is provided so that the grinding wheel can clear the working surface perfectly at both sides and at both ends. The transverse and vertical feed screws are provided with graduated dials with graduations reading in thousandths of an inch. These graduations are sufficiently coarse, so that even smaller sub-divisions can be readily obtained when such a degree of accuracy is required. The table is supported by the well-known knee and saddle construction used in milling machines, ample bearings being provided so as obtain the required rigidity. The vertical adjustment is obtained by a screw, as shown.

The machine is regularly provided with a grinding wheel of 12 inches diameter by 1 inch face, this wheel being intended to run at a speed of 1,400 revolutions per minute. The spindle bearings are cast in one piece with the column of the machine, which provides for rigidity and strength impossible to obtain when the spindle is carried by removable bearings. There is practically no overhang of the spindle at the end where the wheel is carried, thus increasing the capacity of the grinder for heavy cuts. On the opposite end of the spindle an additional grinding wheel is provided and the machine can be furnished either with or without the drill grinding attachment shown. Regularly it is furnished with this attachment which is of the well-known "New Yankee" type, which does not require any preliminary adjustments for bringing the drill in the proper position for grinding. The capacity of the attachment can be varied to suit the requirements of any individual shop.

NEW MACHINERY AND TOOLS NOTES

Four-Spindle Drill: American Watch Tool Co., Waltham, Mass. This machine consists of four independent sensitive bench drills mounted on a cast iron base-plate and adjustable to any position along the base. The spindles are operated by a foot treadle on the floor. The base-plates can be furnshed in lengths varying from 10 to 23 inches.

Quick Adjusting Micrometer: H. O. Costello, 87 Oakland Ave., Providence, R. I. This tool is an improvement on the quick adjustment micrometer mentioned in a brief note in the November, 1908, issue of Machinery. By means of a ratchet arrangement the barrel is adjusted rapidly for position without making use of the micrometer screw for the full length of the adjustment.

Bolt Pointing Machine: Webster & Perks Tool Co., Springfield, O. This machine is intended for pointing the ends of rods from ¼ to ½ inch in diameter. The operation is very simple: The operator places the piece to be pointed in a vise against a stop and presses a foot lever; this grips the work and brings the cutter head forward. In this way, bolts can be pointed as rapidly as the operator can handle them.

Sixty-Degree Drafting Board: Emmert Mfg. Co., Waynesboro, Pa. This drawing board, known as the Noyes board, slides at a 60-degree angle, its weight being balanced so that it moves easily up or down. The frame is placed on any flat top table, and is usually provided with a board or leaf in addition to the inclined one, which is nearly horizontal and which can be used for calculations and reference drawings.

Saw Sharpening Machine: Hunter Saw & Machine Co., 59th and Butler Sts., Pittsburg, Pa. This machine has been designed for sharpening circular milling saws, and sharpens not only the faces and the tops of the teeth, but also bevels the cutting points in such a way as to materially add to the life of the saw and at the same time make it consume less power when in operation. Saws from 6 to 54 inches can be sharpened on the machine.

Breast Drill: North Brothers Mfg. Co., Philadelphia, Pa. With this drill two speeds are available, either of which can be obtained instantly, even when the drill is in motion. The tool is also so designed that it can be used either as a regular breast drill or as a right- and left-hand ratchet brace. These and other special features introduced in this drill, which differs considerably from the ordinary type, make it a very convenient tool for a great many different purposes.

Electric Hoist: Gustav Rasmus, 514 West 57th St., New York City. This hoist, while having a capacity of 5 tons, requires only 35¾ inches head-room, and weighs only 500 pounds. This is due to the fact that the motor is placed inside of the hoist drum, which constitutes the motor frame. The drive from the armature shaft is through a worm and worm-wheel, so that load and speed brakes are not required, as the gears are locked in position by the worm when the motor is at rest.

Large Drop Hammer: Erie Foundry Co., Erie, Pa. This machine is of very large dimensions, it being a 3,500-pound hammer, with an anvil block weighing 70,000 pounds. The entire weight of the hammer is 98,000 pounds. The hammer is provided with a piston stop placed at the top of the cylinder, which protects the cylinder head against damage due to carelessness or to the breaking of the rods or pulling loose of the cross-head. Adjusting screws are provided for cross movement of the anvil for lining up the dies quickly.

Precision Bench Lathe: American Watch Tool Co., Waltham, Mass. This machine is of the usual bench lathe type but some improvements have been introduced, particularly as regards the bearings for the spindle in the head-stock. The front end of the head-cone is also provided with graduations corresponding to the index holes at the back of the cone, mak-

ing it unnecessary for the operator to move from his position in order to set the index. The machine has a bed 36 inches long with a swing of 8½ inches and a chuck capacity of ⅝ inch.

Bench Profiling Machine: American Watch Tool Co., Waltham, Mass. This miniature profiling machine is designed along the same lines as the ordinary profiling machine with a vertical spindle and a guide located beside it. The vertical movement of the spindle is 1 inch and the cross movement 1⅞ inch. The slide or table below the spindle is capable of a 4-inch movement. By a simple arrangement the same handle operates both the vertical movement of the spindle and the side movement along the cross-rail of the slide carrying the spindle bearings.

Disk Grinder: Ransom Mfg. Co., Oshkosh, Wis. This grinder, designed especially to meet the requirements of the automobile trade, is furnished with disks either 23 or 27 inches in diameter; one grinding disk is provded at each end of the frame or column, the driving pulley being placed in the center between the spindle bearings. The work-tables at each end of the machine have independent lever feed, so that two operators can work simultaneously. Both tables can be tilted to an angle of 45 degrees with the face of the disk, and can be raised or lowered as desired.

Armor Plate Slitting Shear: Buffalo Forge Co., Buffalo, N. Y. This machine is not intended for cutting armor plate, as the name would imply, but the frame of the shear is made from armor plate which is a particularly touch and tenacious material and possesses a high elastic limit, especially suited for a machine of this character, subjected as it is to sudden and severe strains. The shear will cut metal of any width up to ¼ inch in thickness, and while possessing the requisite strength, it is, owing to the material from which it is constructed, lighter than any shear of similar capacity.

Milling Attachment for the Drill Press: E. C. Bliss Mfg Co., 91 Sabin St., Providence, R. I. This attachment is intended to be placed on the regular drill press table and is provided with slides in two directions so that milling operations can be performed by an end milling cutter placed in the drill press spindle. The working surface of the table is 8¾ by 21¼ inches, having a longitudinal movement of 9 11/16 inches and a cross movement of 5¾ inches. No swivel is provided, as the drill press table can be swung around when required. The adjusting screws have graduated collars reading to 0.001 inch. The weight of the device is 110 pounds.

Improved Lifting Magnet: Cutler-Hammer Clutch Co., Milwaukee, Wis. An improvement of this company's lifting magnet, shown in the September, 1907, issue of Machinery, has recently been made. The new magnet is of a smaller size and lighter than those previously described, but its lifting capacity is nearly as great. In the design, attention has been given to the conditions under which a device of this kind is operated, and the magnet can be used out-of-doors in any kind of weather without damage. Pig iron has been unloaded from gondola cars by means of it at the rate of 100 tons per hour and at a cost of ½ cent per ton, as against 5 or 8 cents per ton for manual labor.

Universal Monitor Lathe: Dreses Machine Tool Co., 227-239 West McMicken Ave., Cincinnati, O. This machine, as the name indicates, is provided with a turret and turret slide, the latter being provided with set-over and swivel. The top slide has combined lever and screw feed, and all slides have taper adjusting gibs. The turret is locked by a gibbed square key. The head and bed of the machine are cast in one piece, with entirely enclosed friction back-gearing. The entire operating mechanism of the friction in the head can be put in place and removed without taking out the spindle. A taper attachment is provided, placed separately on the bed below the V's, having knurled screws for fine adjustment.

New Line of Upright Drills: Cincinnati-Bickford Tool Co., Cincinnati, O. This company has redesigned its line of upright drills, including the 20-inch sensitive drill, the 21-inch drill with stationary head and the 21-inch drill with sliding head. Among the improvements included in the 20-inch drill are graduations on the spindle sleeve and an automatic stop for tripping when the required depth of hole has been drilled. In addition, ample guards have been provided for all gearing. The 21-inch machine has been provided with a new tapping attachment. This machine is back-geared, the back-gears being operated by a lever-controlled clutch. Power feed is provided by means of cone pulleys and worm and bevel gearing. In the sliding head machine, the head has a movement of 17½ inches, the table a movement of 16¾ inches and the spindle a traverse of 9 inches, giving the machine a large range. Improvements in the design of the full line of upright drills from 24 to 42 inches have been made, to make the machines capable of using high-speed drills to their full capacity.

* * *

"Most of the books on trigonometry are elaborate enough for a surveyor or an astronomer. A machinist doesn't want so much. For him to learn it all is too much like scraping something true to a surface-plate where it only fits against thin air."—*Extract from a letter.*

CHICAGO DUPLEX FEATHER KEYSEATING MACHINE

In the August, 1909, issue of Machinery a description of the Chicago duplex hand milling machine was published. The accompanying half-tone engravings, Figs. 1 and 2, show this machine in operation with both the vertical and horizontal spindles in use simultaneously. When thus arranged, the machine is intended in particular for the quick handling of feather keyseating work. The horizontal spindle is fitted with an arbor having a No. 9 Brown & Sharpe taper shank, the shank being held in place by a draw bar. On this arbor is mounted the required cutter for cutting the desired width of the feather keyseat. In the vertical spindle is placed an end mill of the required size, which is held in place by a draw-in collet.

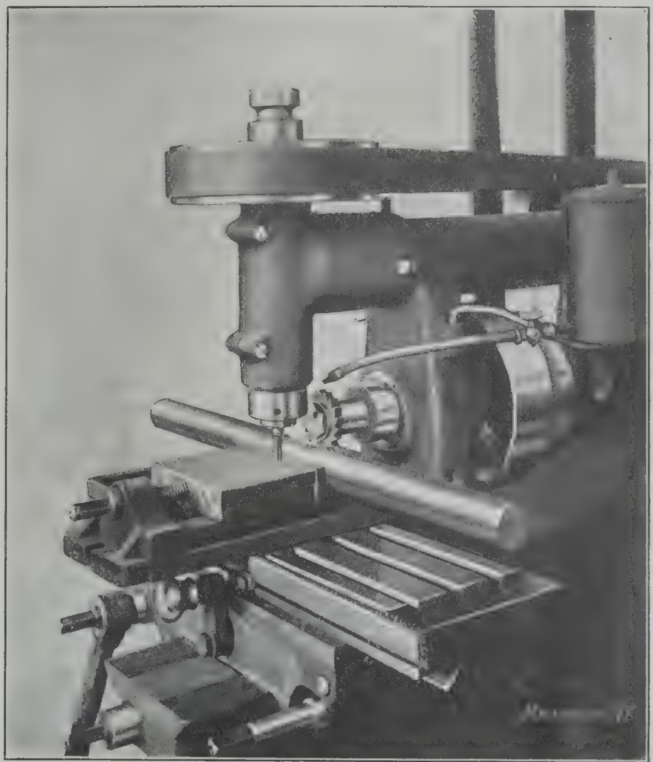


Fig. 1. First Operation in milling a Feather Keyseat on the Chicago Duplex Milling Machine

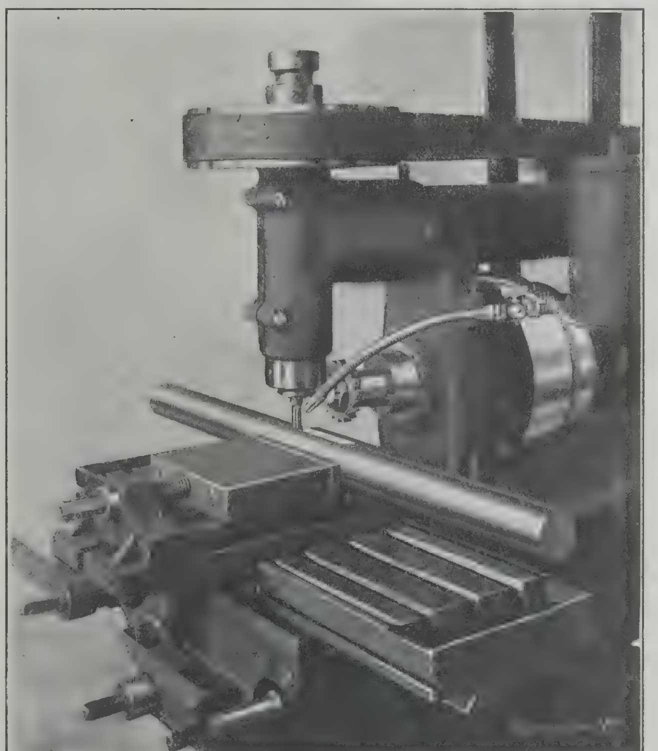


Fig. 2. Second Operation in milling the Feather Keyseat

In Fig. 1, the machine is shown performing the first part of the operation of cutting a feather keyseat. The shaft in which

the keyseat is cut is held in a vise, and the side milling cutter shown mills out the keyseat excepting the finishing of the ends. This part of the operation is performed by the end mill in the vertical spindle, as shown in Fig. 2, where the table carrying the vise and shaft has been brought directly beneath the end mill. This makes a very handy arrangement for milling feather keyseats, as the two complete operations necessary for the milling can on this machine be made without resetting the work or even stopping the machine; thus, in reality, it may be considered as a continuous operation. The machine is equipped with six changes of power feed as well as crank and lever feeds, thus having a sufficient range to cover all ordinary work. The hand-lever feed is brought into service when the table is quickly returned after a cut has been taken. An adjustable automatic stop to the table feed is also provided which can be set for the length of keyseat desired. Hill, Clarke & Co., Inc., 125 North Canal St., Chicago, Ill., are the selling agents for this machine.

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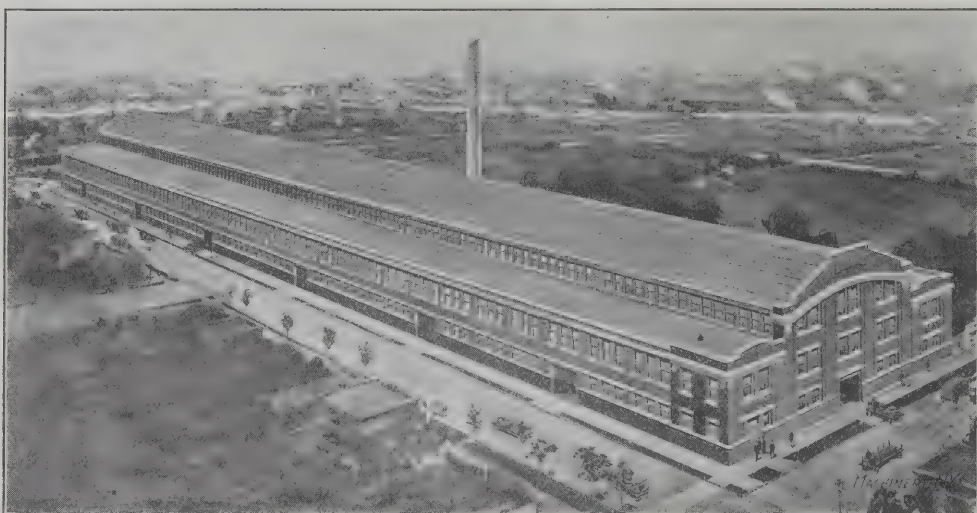
CHICAGO MACHINERY EXHIBITION WAREHOUSE

The illustration shows a new machinery exhibition warehouse just completed in Chicago that is 100 feet wide and 400



Reinforced Concrete Machinery Warehouse just completed in Chicago at 37th Street and Ashland Avenue

feet long and absolutely fireproof, being built of reinforced concrete throughout. It is located at 37th St. and Ashland Ave., on the Chicago Junction Railway, connecting with all railroads and boat landings. It was built by the Pfannmueller Engineering Co. to plans supplied by architect A. S. Alschuler, and was erected by general contractors J. P. & J. W. O'Connor.

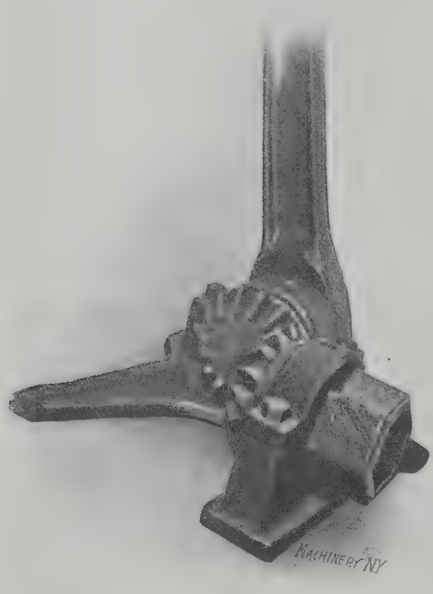


Fig. 1. Ratchet Wrench for Tightening Tie-rod Nuts on Pipe laid in a Trench

The building is three stories high in front, two stories on the sides and one story in the center. The offices are on the three floors in the front of the building and run across the entire width of the building, giving office space on the second story 20 by 100 feet and on the third story 20 by 50 feet. The space in the center of the building, 50 feet wide by 40 feet high, runs the entire length of the building and is absolutely unobstructed. It is spanned by a 50-foot 25-ton Alliance traveling crane having a 6-ton auxiliary. The balconies on the sides are supported by massive concrete columns 20 feet apart, and these also support the crane runway. The spaces on the ground floor beneath the balconies are 20 x 25 feet, and may be partitioned off when so desired and thus make individual exhibition and storage rooms. In order that heavy machinery may be handled readily on the first floor, eye-bolts are set

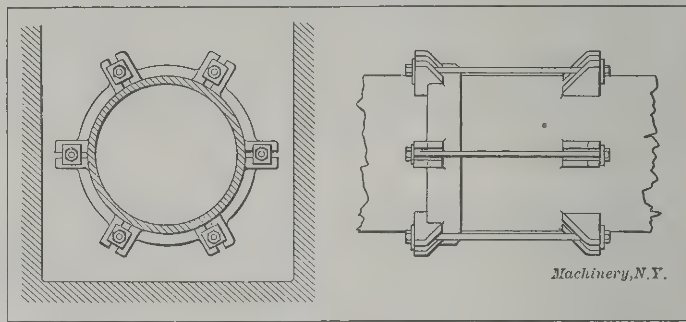


Fig. 2. Illustration showing the Work for which the Wrench shown in Fig. 1 was designed

every ten feet in the brick wall to provide a means of attaching block and tackle to be used in connection with the crane for pulling heavy machinery into and out of these spaces. The balcony floors extend into the middle space 5 feet under the crane and are equipped with removable rails, thus providing a passageway and means by which the crane can serve the balcony. The building will be finished with all modern conveniences, including electricity, steam heat, ample toilet arrangements, shower baths, telephone switch-board with several trunk lines, etc.

In the rear of the structure there is a paved yard, fenced in, 100 feet wide and 160 feet long which will be used for rough machinery and metal products that do not necessarily have to be kept under cover. This space provides for the extension of the building. A private switch from the Chicago Junction Railway enters the building at the rear.

The building is located in the center of the manufacturing district and in the geographical center of Chicago. It is accessible by numerous car lines, and in view of the unsatisfactory conditions generally existing in Chicago affecting salesrooms and warehouses, it is believed that the new venture will fill a long-felt want. The fact that the equipment will handle heavy machinery at a minimum cost and that there will be no switching charges on carload shipments either incoming or outgoing, makes possible a big saving of charges now borne by the machinery warehouses not located so advantageously or provided with modern handling equipment.

* * *

RATCHET WRENCH FOR TRENCH WORK

The Philadelphia Gear Works was called upon recently to design some form of wrench for tightening 1¼-inch hexagon nuts at the bottom of a trench 3 feet wide and 10 feet deep. These nuts were on the tie-rods of a 20-inch cast-iron pipe line (see Fig. 2) where there was very little room in which to work, and some special arrangement was necessary for tightening them. To enlarge the trench was not advisable as excavating was done at so much per cubic yard, and as there were fifteen miles of pipe being laid, the idea of widening the trench at each joint to permit of the use of an ordinary wrench, was abandoned. The device shown in Fig. 1 was designed and does the work admirably. This wrench is simple in its construction as it consists of nothing more than a hexagon cup to fit the nut, a pair of miter gears mounted on a light frame, and a reversible ratchet and lever. As will be understood, the miter gears are to bring the ratchet shaft at an angle of 90 degrees with the axis of the wrench proper, so that the wrench lever is in line with the trench, thus giving plenty of room for its operation. With this device one man can tighten the two bottom nuts with less profanity and

time than is required to set up the four more accessible nuts with an ordinary ratchet wrench.

* * *

SPARKS AS INDICATIONS OF DIFFERENT KINDS OF STEEL*

The sparks given off when grinding iron and steel, by means of emery wheels, present a different appearance according to the kind of material ground. In the following, a review is made of the appearance of the sparks of different materials, and explanation is given of the causes of the differences, and the practical applications of this method of steel testing are pointed out.

The path of the spark from its origin to its extinction forms a line of light which may be called the spark-ray. This spark-ray consists of a line of light the end of which branches out in every direction, having an explosion-like appearance. It is this end of the rays that, in particular, varies for different classes of steel, and which in the following will be called the spark-picture. Some of these spark-pictures contain only a very few lines, while others contain a great many, some of them presenting secondary explosions and projections. The rays extending from the drop formation in the spark-picture have a strikingly higher speed than the particles in the spark-rays, and it appears as if they were suddenly thrown out in various directions by an internal force.

With a carbon content of from 0.07 to 0.08 per cent, the number of the lines in the spark-picture is from two to three. With an increase of the percentage of carbon the number of the branching lines also increases. At low carbon contents the lines appear to start from different points of the drop formation at the end of the ray, but when the carbon content is as much as 0.25 to 0.27 per cent the lines spring from a common point of the drop formation. The larger the carbon content the greater is the crowding of the lines projecting from the end of the ray. (See Fig. 1.)

The spark-picture of steel containing manganese (see Fig. 2) shows at the end of the individual branching lines a secondary explosion-like phenomenon, shorter lines collecting like leaves around a common central point. The number of the primary branching lines in this case also is in proportion to the carbon percentage in the steel; the extent and shape of the spreading ends of the primary branching lines appear to be in a certain relation to the percentage of manganese contained by the material.

In the case of tool steel, the spark-picture resembles the branch of a blossom, and the individual branching lines have a lilac-like form.

The spark-rays of steel containing wolfram are dark red lines, the ends of which show no spark-picture if the emery wheel is not sufficiently sharp and the pressure between the wheel and steel is small. Only the very end of the ray has a broader and more brightly glowing appearance, indicating the beginning of a spark picture. If the steel is pressed more firmly against the wheel, branching lines spring out in an explosion-like manner. These lines, however, take the form of small shining pin-head-like balls.

The spark-sheave (the combination of spark-rays and spark-pictures) of chrome-wolfram high-speed steel is distinct from that of the wolfram steel by the fact that two kinds of rays appear, some very thin dark red, and some thicker bright red ones, which are absent in the regular wolfram steel. The spark-pictures consist solely of short curved drop forms.

The spark-picture of nickel steel, containing less than three per cent nickel, is identical with that of carbon steel with a corresponding percentage of carbon. In case of larger percentages of nickel, however, the nickel steel can readily be recognized by the aid of the spark test, because the spark-pictures show themselves in a sporadic manner whereas in the case of carbon steel they occur in close proximity and in close succession to one another.

Fig. 1. Spark-picture indicating High-carbon Steel — Fig. 2. Spark-picture of a Tool-steel containing Considerable Manganese — Fig. 3. Spark-picture of Steel containing Wolfram — Fig. 4. Spark-picture of Molybdenum High-speed Steel

Dark gray cast iron is characterized by fine dark red spark-rays, spark-pictures here and there, and lines collecting around the drop formation like a net. The net-like lines disappear more and more with the increase of assimilated carbon, and with light gray cast iron they disappear altogether.

Theory of Spark Formations

The spark emitted when grinding is of course a particle of the metal being ground, heated to a high temperature by the friction between the emery wheel and the material. This particle of metal is thrown out in a tangential direction. At a certain point of its line of flight, the red hot spark assumes a red heat; it changes to white heat, and then transforms itself in an explosion-like manner into a spark-picture. At the moment of the explosion-like transformation the spark is in a fluid state. The latter statement can be proved by introducing a plate of glass at right angles to the line of flight and microscopically examining the glass. It is apparent that the sparks must be in a fluid condition, as they either splash asunder when striking the glass or form crystals of different shapes.

The increase of heat of the spark is caused by an internal source of heat represented, partly, by the combustion heat of the carbon, which suddenly burns. The heat of oxidation of

* Abstract from a paper by Mr. Max Bermann read before the Copenhagen Congress of the International Association for Testing Materials.

the exterior surface of the mass of sparks prevents too rapid cooling of the spark. The heat of cumbustion of the carbon provides the quantity of heat necessary for melting the metal. As a matter of fact, however, this heat is not sufficient to melt the whole mass, because the amount of carbon is too small, and only the mass of the unoxidized core within the oxidized iron crust is melted by the quantity of heat available. The combustion gases of the carbon burst the outer crust of the spark mass and throw out the fluid contents in the direction of the primary branching lines. The silicon and phosphorus contained also burn at the melting heat of the iron, and raise the temperature of the fluid mass. This theory explains why the size of the spark picture increases with the percentage of carbon.

Practical Applications of the Spark Test

The most important practical applications of the spark test may be stated as follows: Different kinds of iron may be classified according to their carbon percentage and the metals principally alloyed with them; ends of rods which may have been wrongly arranged on the storing racks may be placed against the revolving emery wheel and thus identified. It is stated that the spark test is so sensitive that differences of 0.01 per cent of carbon may be perceived. In the inspection of received material the method is valuable for making a rapid test to make sure that the material complies with the requirements. The spark test also supplies a sensitive means of ascertaining differences in chemical composition at different places of the same bar or piece of material, it being possible to apply this test to both steel and cast iron. In the hardening room the spark test may also be of value in order to make sure before hardening what grade and class of steel has been used for making the various tools, so that the proper hardening process may be applied. In the forge shop the method may be of value for determining with certainty good malleable wrought iron.

* * *

PERSONAL

G. W. Hoffman has been appointed sales engineer in charge of the Chicago office of the Hill Clutch Co., Cleveland, Ohio.

R. K. Loofbourrow is the newly appointed purchasing agent of the Electric Welding Products Co., Cleveland, Ohio.

H. O. Connelly, recently assumed the management of the New York office of the Cleveland Pneumatic Tool Co., Cleveland, Ohio.

B. L. Waters, of Aurora, Ill., is establishing an Eastern Branch of the Lyon Metallic Mfg. Co., in New York, with headquarters at 1365 Hudson Terminal Building.

Richard B. Sheridan has been promoted from chief sales engineer to assistant general manager of the Brown Hoisting Machinery Co., Cleveland, Ohio.

Charles F. Baehr, for twelve years with the Northern Electric Mfg. Co., has taken the position of superintendent of the Globe Machine & Stamping Co., Cleveland, Ohio.

Ernest L. Smith, lately eastern representative of the Standard Roller Bearing Co., Philadelphia, is now sales manager of the Grant-Lees Machine Co., Cleveland, Ohio.

Albert Bayton, formerly tool-room foreman for the Reed Mfg. Co., Erie, Pa., is now superintendent, succeeding F. Hubbard, deceased.

George W. Johnson, for the past four years superintendent of the Chapman Valve Mfg. Co., Springfield, Mass., has resigned his position.

H. L. Hunter has been transferred from Edgemont, South Dakota, to Alliance, Neb., to take charge of the machine shops of the C. B. & Q. R. R.

W. M. Corse, secretary and treasurer of the American Brass Founders' Association, has been made works manager of the Lumen Bearing Co., Buffalo, N. Y.

William Perrine has been appointed master mechanic of the New Jersey Central and Lehigh and Susquehanna divisions of the Central Railroad of New Jersey.

George W. Fuller, for forty-seven years master mechanic of the Estey Organ Co., Brattleboro, Vt., has resigned his position and will spend the remainder of his life on "easy street."

Frank Davis, superintendent of the Haydenville Co.'s brass works, Haydenville, Mass., has resigned, and Fred Noble, assistant superintendent, has been made superintendent.

William Spire, formerly superintendent of the Marine Gas Engine Co. of New Jersey, has taken the position of mechanical engineer of the Electric Welding Products Co., Cleveland, Ohio.

A. N. Frecker, who has been for some years in the electric drill and grinder business at 95 Liberty St., New York, has been made general sales manager of the Van Dorn Electric & Mfg. Co., Cleveland, Ohio.

W. S. Howe, formerly advertising manager in charge of the small tools sales department of the Canadian-Fairbanks Co., Ltd., Montreal, has become associated with the S. A. Woods Machine Co., wood planer specialists, Boston, Mass.

Eugene Childs, formerly connected with the Trimont Mfg. Co., Roxbury, Mass., has been made president and general manager of the Springfield Drop Forge Co., Springfield, Mass, recently acquired by the Lakeside Forge & Wrench Co., Springfield, Mass.

W. S. Giel, lately superintendent of the Stoever Foundry & Mfg. Co., Myerstown, Pa., has severed his connection with that concern. Mr. Giel will devote his time to special work. His address is 3 Hamilton Park, New Brighton, Staten Island, New York.

Dr. W. H. Tolman, director of the Museum of Safety and Sanitation, 29 W. 39th St., New York, delivered an illustrated lecture before the National Machine Tool Builders' Association, Hotel Astor, October 13; also the same before the Liability Insurance Association at the Hotel Astor, October 20.

Howard Terhune, author of the article "Board Drop Hammer Design," published in this number, engineering edition, has resigned from the employment of Billings & Spencer Co., Hartford, Conn., and has taken a position with the E. W. Bliss Co., Brooklyn, N. Y.

Augustus M. Kelly, has resigned his position of foreman of the machine molding department of the Chapman Valve Mfg. Co.'s foundry, Springfield, Mass., to take the position of superintendent of the American Blower Co.'s foundry, Detroit, Mich., and has assumed his new duties.

H. A. Elliott, formerly with Alfred Schütte of Cologne, Paris and New York, has taken the position of American agent of Usines G. Derihon of Loucin, Belgium, specialist in the manufacture of automobile forgings. Mr. Elliott's headquarters are at 7502 Carnegie Ave., Cleveland, Ohio.

The personal note published in the April number stating that James W. Ogden, formerly superintendent of the Bridgeport Foundry & Machine Co., Bridgeport, Conn., had been made superintendent of the Wolverine Motors Works, Bridgeport, was erroneous. Mr. B. A. Yarrington is the superintendent.

H. J. Brandes, formerly connected with the Bullard Machine Tool Co., Bridgeport, Conn., in the capacity of superintendent, has severed his connection and has taken up the active management of the Springfield Mfg. Co., Bridgeport, Conn., maker of special grinders and emery wheels. Mr. Brandes purchased the business from Mr. George Jackman, who has retired.

Dr. William H. Tolman, director of the Museum of Safety and Sanitation, 29 West 39th St., New York, has completed arrangements for a lecture tour dating from October, 1909, to March, 1910, the itinerary of which includes the principal cities and towns in the New England, Middle and Middle Western States north of the Ohio and east of the Mississippi River, and a few cities west of the Mississippi, comprising St. Louis, Cedar Rapids, Davenport, Des Moines, and Burlington.

Aguste Isaac, president of the Chamber of Commerce, Lyons, France, visited America in October to study industrial conditions with special reference to the apprenticeship training of young men for the machinist's and other trades. He found a striking similarity between labor conditions in France and America as regards difficulty of holding boys to the terms of their indentures. They have the bad habit in France of working a year or two and then leaving and hiring out to other manufacturers as journeymen. The consequence, of course, is that there are many "half-baked" French machinists.

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OBITUARIES

Edward T. Coe, treasurer of the Coe Brass Co., Torrington, Conn., died at his home in New Haven, Conn., October 5.

Carl Wilcox, of Wilcox & Gibbs, New York, a sewing machine inventor, died at his home in Westport, Conn., aged sixty-five years.

L. L. Heller, president of the Sterling Motor Car Co., Binghamton, N. Y., was killed October 6 by being struck by a Lehigh Valley R. R. train, near Waverly, N. Y.

Albert J. Perks, partner of the Webster & Perks Tool Co., Springfield, Ohio, died at his home in Springfield, October 4, aged fifty-eight. Mr. Perks was born in Birmingham, England, and came to America with his parents when a child. His parents located at Dayton, Ohio, where Mr. Perks spent his boyhood. He moved to Springfield when about eighteen, and since then has been actively engaged in manufacturing enterprises. For a number of years he was superintendent of the bar and knife department of the old Whiteley Machine Co., located where the Foos Gas Engine Co. now is. In October, 1891, he severed his connection with the Whiteley interests and entered into partnership with John F. Webster to manufacture machine tools under the firm name of Webster & Perks

Lewis C. Grover

Tool Co. Mr. Webster died in December, 1893, and Mr. Perks carried on the business alone until 1898, when Mr. Herman Voges, Jr., became associated as a partner in the business, which arrangement was carried on up to the time of Mr. Perks' death. Mr. Perks was an expert mechanic and machine designer, and an inventor of a number of valuable appliances. He is survived by his widow and two sons, George W. and Bert W.

LEWIS C. GROVER

Lewis C. Grover, chairman of the board of directors of Colts Patent Fire Arms Mfg. Co., Hartford, Conn., and for several years president of the company, died at his home in Hartford, September 30, following an illness of about three years. Mr. Grover was born, 1849, in Springfield, Mass., and was educated in the public schools. He served an apprenticeship to the machinists' trade in the Norwalk Iron Works, South Norwalk, Conn., and such was his aptitude for mechanical work that he was made foreman on the completion of his apprenticeship term. When only twenty-eight he accepted the position of general manager of the Whitney Arms Co., at New Haven, which position he held six years. In 1886 he was made assistant superintendent of the Colts Patent Fire Arms Mfg. Co., and soon became superintendent, and then general manager. In 1902 he was elected president and a director of the company to succeed John H. Hall. He was also elected president of the Colts Arms Co., of New York. He resigned the office of president of both companies last January because of poor health, but was elected chairman of the board of directors of each company. Mr. Grover was a man highly esteemed by his friends and employes. He was an indefatigable worker, and, although a broad-minded manager who understood how to delegate authority to subordinates and hold them responsible for results, no detail of the large manufacturing business which he managed was too trifling to receive his attention.

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COMING EVENTS

November 9.—Monthly meeting of the American Society of Mechanical Engineers, Engineering Societies Building, 29 West 39th St., New York. Two papers will be presented; one by Prof. Gaetano Lanza and Lawrence S. Smith of the Massachusetts Institute of Technology on reinforced concrete beams, and the other by Prof. Walter Rautenstrauch of Columbia University on stresses in curved machine members. The paper on reinforced concrete beams compares the results of tests upon full size beams made at the Massachusetts Institute of Technology and the University of Illinois with three different theories of beams of this type. The paper on stresses of curved machine members outlines the method of procedure for the design of principal sections of hooks, punch and shear frames and other curved machine parts. Experimental results will be submitted in support of the theory presented. Calvin W. Rice, secretary, 29 West 39th St., New York.

November 18-19.—Annual meeting of the Society of Naval Architects and Engineers, Engineering Societies Building, 29 West 39th St., New York. W. H. Baxter, secretary, 29 West 39th St., New York.

November 19-20.—Annual meeting of the Ohio Society of Mechanical Electrical and Steam Engineers, Lima, Ohio. David Gaehr, secretary, Schofield Building, Cleveland, Ohio.

December 1-3.—Annual convention of the National Society for the Promotion of Industrial Education. An exhibition of school work from all over the United States will be one of the features. J. C. Monaghan, secretary, 20 West 44th St., New York.

December 7-10.—Annual meeting of the American Society of Mechanical Engineers in the Engineering Societies' Building, New York. Mr. Calvin W. Rice, secretary, 29 West 39th St., New York.

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

April 1-June 30, 1910.—American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Vieweger, American manager, 50 Church St., New York.

NEW BOOKS AND PAMPHLETS

Annual Report of State Geologist of New Jersey for 1908. 159 pages, 6 x 9 inches. Published for the State by Mr. Henry B. Kümmel, State geologist, Trenton, N. J.

Transactions of the National Association of Cotton Manufacturers: No. 86. 556 pages, 6½ x 9¾ inches. Secretary and Treasurer C. J. H. Woodbury. Room 501, 45 Milk St., Boston, Mass.

Manual of Steam Engineering. By W. H. Wakeman. 411 pages, 3 x 5½ inches. Published by New York Belting & Packing Co., Ltd., for distribution.

This manual will be found valuable by those concerned with the common problems coming up in the power plant. It treats of boilers, boiler feeders and steam engines. Many tables and rules are given that should be appreciated by the stationary engineer and others. Description for setting the valves of duplex pumps and calculating the horse-power of engines are examples.

Manual for Engineers. By Chas. E. Ferris. 165 pages, 3 x 5½ inches. Published by University of Tennessee, Knoxville, Tenn. Price, 50 cents.

This manual, which is a revised edition, contains in convenient form many valuable tables and other data for engineers and business men. Some of the most important tables in the book are as follows: Areas and circumferences of circles; square and cube roots; natural sines, tangents and secants; steam tables dealing with capacity of turbines; extensive tables for electric wiring; interest tables, etc.

Mechanical World Pocket Diary and Year Book for 1910. 391 pages (including advertising), 3¾ x 6 inches. Published by Emmott & Co., Ltd., Manchester, England. Price, 6 pence.

This publication has become quite well known in the United States, this being the twenty-third year of publication. It treats of steam and steam engines, including compound and triple expansion types, details of construction, condensers and condensing plants and condenser details; steam turbines, boilers and boiler construction, chimneys, super-heating, feed water, fuels, gas and oil engines, gas producers, centrifugal pumps, beams and girders, shafting, gearing, ball bearings, belting, rope drives, wire ropes, bolts and nuts, screw threads, screw cutting, miscellaneous mathematical tables, etc.

Metal Spinning. By Fred D. Crawshaw. 74 pages, 4¾ x 6¾ inches. 33 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Bound in cloth. Price, 25 cents.

Metal spinning, while once of considerable importance, is an art that is going into decline and, strange to say, it is one on which it is claimed no book had been published until the appearance of this work. The present practice is to employ drawing and forming press tools to produce the work that was formerly made on the spinning lathe. The work recognizes this fact and was written largely for the instruction of amateurs, trade schools, and the crafts which produce art work in limited amount. The tools, chucks and samples of work produced are illustrated and described. The book will be found of considerable general interest because of the fact that no other work on the subject has been published and also because of the interesting character of the operations and tools employed.

Efficiency as a Basis for Operation and Wages. By Harrington Emerson. 171 pages, 5 x 7 inches. Published by the *Engineering Magazine*, New York. Price, $2.

This work is based on the articles published under the same title in the *Engineering Magazine* from July, 1908, to March, 1909, revised, rearranged and expanded by the author. Mr. Emerson is a well-known works management engineer who has given years of scientific study to the problem of efficiently employing labor and securing the highest efficiency by intelligent direction of effort. The philosophy of works management is slowly taking shape, and Mr. Emerson's treatment will be found exceedingly interesting by those concerned with it either in theory or in stern practice of everyday life. The contents by chapters are: Typical Inefficiencies and their Significance; National Efficiencies—Their Tendencies and Influence; The Strength and Weakness of Existing Systems or Organization; Line and Staff Organization in Industrial Concerns; Standards—Their Relations to Organization and to Results; The Realization of Standards in Practice; The Modern Theory of Cost Accounting; The Location and Elimination of Wastes; The Efficiency System in Operation; Standard Times and Bonus; What the Efficiency System may Accomplish; The Gospel of Efficiency.

Notes on Practical Mechanical Drawing. By Victor F. Wilson and Carlos L. McMaster. 186 pages, 6 x 9 inches. 86 illustrations. Published by Wilson & McMaster, East Lansing, Mich. Price, $1.50.

This book which treats of lettering, orthographic projection, isometric and oblique drawing, use of instruments, working drawings, geometrical drawing, machine sketching, etc., has been revised, rearranged and enlarged by 25 pages for the third edition. The chapter on lettering describes the various types of lettering commonly used on mechanical drawings, and illustrates a number of examples. Considerable attention has been given to orthographic projection, examples being given from which the student can get a clear idea of the relation of the three common views used in the ordinary mechanical drawing. The sketches in phantom perspective are well executed and give the work an attractive appearance. Practical instructions are given for making working drawings that agree very well with the common usage of draftsmen in manufacturing establishments. The book is one that can be recommended to industrial schools and all students who wish to study mechanical drawing at home or to others who wish to obtain a knowledge of the common relations of views and methods of making drawings without going to the trouble of learning to draw.

Power, Heating and Ventilation. By Charles L. Hubbard. 647 pages, 6 by 9 inches, 412 illustrations. Published by the Technical Press, Brattleboro, Vt. Price, $5.

This book is intended for designing and constructing engineers, architects, etc. The subject of power is treated especially from the steam side, but sufficient information bearing on electrical matters is given to enable the intelligent arrangement of the steam plant with reference to the requirements of electric lighting and the distribution of electrical power. The subject of boilers is quite fully treated, and much valuable information is given on the construction of various types, the design of tubular boilers, boiler accessories, care and management, etc. The theory of the steam engine is taken up and descriptions of different types given, including the steam turbine. The subject of condensers is also treated, and the use and construction of cooling towers explained. A chapter devoted to steam and feed piping contains many valuable tables and formulas and also considerable information of practical value to the engineer. The problem of heating and ventilation as applied to all classes of buildings, from a small furnace-heated dwelling to buildings with central plants of the largest size, is fully treated. The various chapters dealing with this subject are as follows: Systems of Warming; Ventilation; Heat Loss from Buildings; Furnace Heating; Direct Steam Heating; Indirect Steam Heat-

ing; Direct Hot Water Heating; Indirect Hot Water Heating; Forced Hot Water Circulation; Fans; Forced Blast Heating and Ventilation; Exhaust Steam Heating; Electric Heating; Special Devices; Heating and Ventilating Different Types of Buildings; Care and Management of Heating and Ventilating Plants.

ELEMENTS OF MACHINE DESIGN. By Dexter S. Kimball and John H. Barr. 446 pages, 6 x 9 inches, 196 illustrations. Published by John Wiley & Sons, New York. Price, $3.

We have often been impressed by the fact that there is no American book on machine design that gives all of the many common subjects of machine design on which the designer is likely to require specific information. Reference usually must be made to a number of the available works before a satisfactory treatment of a given subject is found. The authors of the present work evidently having noted the shortcomings of previous writers have presented, we believe, a book on machine design that is more complete than anything of a similar nature put on the market by American publishers. The work is the outgrowth of the experience of the authors in teaching machine design to engineering students in Sibley College, Cornell University. The treatment of friction, lubrication and efficiency are sufficiently comprehensive for a work of this kind, as is also the work on springs, riveted fastenings, screws and screw fastenings, keys and cotters. The theory of stresses produced by force fits and the calculation of allowances is satisfactory, but an improvement is suggested in the shape of a table giving the results of practice in making shrink and force fits. So many factors enter into the problem that the result of practice on various classes of work would be exceedingly helpful to the designer who has not had the benefit of much experience. The treatment of tubes, pipe, cylinders, flues and tin plates was written with the advantage of the knowledge gained from the experiments made by the University of Illinois Engineering Experiment Station and the paper by Prof. Reid T. Stewart presented before the American Society of Mechanical Engineers, and, of course, is much more satisfactory than previous treatments available in other works on machine design. Journal bearings, pivots and roller bearings, are not treated in as comprehensive a manner as one who is especially interested in these subjects could wish, but probably as much space is given to these important subjects as the general plan of the work and the course of instruction for which it was prepared would permit. A portion of the book is devoted to axles, shafts and shaft couplings, belt, rope and chain transmission, application of friction including friction reels, friction brakes, friction clutches and pulleys. The treatment of tooth gearing is fairly satisfactory, there being forty-two pages devoted to the theory and practice of spur, bevel and helical gearing. Of course, the treatment of helical and spur gearing is brief and leaves a great deal unsaid. Following this chapter are chapters on fly-wheels and pulleys and machine frames and attachments. The work is one that we can heartily recommend to machine designers and others concerned with the problem of machine design, but it is not quite the comprehensive treatment that should be presented by some author. Whether a comprehensive treatment is practical is a matter for the publishers to decide, but the need for a good all-around work is evident to those who frequently refer to the present available books on machine design.

CATALOGUES AND CIRCULARS

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletin No. 4698 of luminous arc head-lights.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletin No. 4691 illustrating and describing small polyphase motors.

VALLEY BOAT & ENGINE Co., Baldwinsville, N. Y. Catalogue of marine engine castings and finished machine parts.

GISHOLT MACHINE Co., Madison, Wis. Leaflet illustrating the Gisholt 30-inch motor-driven vertical boring mill.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletin No. 4692 describing the General Electric No. 210 Railway Motor.

BICKFORD & WASHBURN, INC., Greenfield, Mass. Blotter illustrating the Bickford & Washburn pipe tap thread milling machine.

PRENTISS TOOL & SUPPLY Co., 115 Liberty St., New York. Circular of the 20-inch universal drilling lathe built by Fay & Scott, Dexter, Me.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletin No. 4099 superseding Bulletin No. 4444 on motor-driven air compressors, geared type.

SPICER UNIVERSAL JOINT MFG. Co., Plainfield, N. J. Catalogue of Spicer dust-proof and oil-tight universal joints for motor cars, motor boats and other machinery.

ARGUTO OILLESS BEARING Co., Wayne Junction, Philadelphia, Pa. Folder advertising the Arguto oilless bearings which save oil and prevent ruined journals.

W. S. CALDWELL Co., Louisville, Ky. Catalogue of Caldwell wooden tanks for manufacturing plants and other users requiring large and small tanks for the storing of water, etc.

CLEVELAND TWIST DRILL Co., Cleveland, Ohio. Folder entitled "The Paragon Way" illustrating the new "Paragon" flat taper shank high-speed twist drill lately brought out by the company.

W. S. ROCKWELL Co., 50 Church St., New York. Circular illustrating the Rockwell furnaces, and fuel oil or gas-burning appliances. A new catalogue is in preparation and will be issued shortly.

GEORGE W. SOUTHWICK Co., 35 Warren St., New York. Circular illustrating the Hammond wire belt lacing tool for making a wire hinged joint for machine belting. The cost of the outfit is $7.50.

HARBISON-WALKER REFRACTORIES Co., Pittsburg, Pa. Catalogue of silica, nickel, chrome, and fire-clay brick used by steel mills, brass foundries, and other concerns employing furnaces for melting metals.

J. S. OSGOOD, 131-138 Erie County Bank Building, Buffalo, N. Y. Blotter illustrating the Osgood indestructible file and tool handle which was recently specified by the United States Government for the Rock Island Arsenal.

CUTLER-HAMMER MFG. Co., Milwaukee, Wis. Circular of the Cutler-Hammer pressure controlled speed regulator for use with motor-driven boiler draft fans, boiler feed pumps, gas pressure exhaust, etc. For description see MACHINERY, September, 1909.

ARTHUR D. LITTLE LABORATORY, Boston, Mass. Pamphlet by Harry S. Mork, engineering chemist, entitled "Selective Economy in Raw Materials," being a paper presented at the annual meeting of the American Chemical Society at the New Haven meeting, July 3, 1908.

MANVILLE BROS. Co., Waterbury, Conn. Circular of the "Yankee" power bench press, designed to take the place of the ordinary foot and screw press. It is made in three sizes with or without table. The stroke is 1, 1½ and 2 inches respectively.

PLANET ENGINEERING Co., 5 Beekman St., New York. Circular illustrating the constructive features of the Planet roller bearings for motor boats, thrust bearings, electric motors, centrifugal pumps, etc. This bearing is composed of rollers with the periphery a section of a spherical surface.

GEM MFG. Co., 3253 Spruce St., Pittsburg, Pa. Catalogue of "Gem" specialties, comprising steel and brass oilers, torches, oil carriers, tallow pots, flue scrapers, foundry chaplets, flexible shafts, rope-driven or motor-driven portable grinders and drills, electric polishing machines, universal joints, etc.

H. BRACHARACH, 720 Lewis Block, Pittsburg, Pa. Advance sheets of 1910 catalogue illustrating a German recording gage which measures and records pressure, draft, and velocity of gases. These gages are used in boiler plants, mine ventilating systems, gas producer plants, regenerative furnaces, etc.

THE GRAHAM MFG. Co., Providence, R. I. Blotter illustrating a Universal jig vise, which is made in three sizes with jaws 6, 9 and 12 inches long. This jig vise can be used as a plain drilling vise or for the drilling of interchangeable parts. It is a cheap substitute for expensive jigs on a large class of work.

GARDNER MACHINE Co., Beloit, Wis. Circular illustrating the Gardner grinder in use on intake manifolds, universal joints, pump cases, exhaust connections, jacket plates, and cylinder covers, all being examples of automobile work for machining which the disk grinder has been found to be a valuable tool.

BOGERT GAS POWER ENGINE Co., 1116 Chamber of Commerce, Buffalo, N. Y. Folder illustrating the Bogert tandem gas engine built in sizes from 50 to 500 horse-power; also Bogert tandem gas engines with no cross-head built in sizes from 50 to 150 horse-power and single cylinder gas or gasoline engines in sizes from 20 to 100 horse-power.

B. F. STURTEVANT Co., Hyde Park, Mass. General catalogue No. 165 illustrating the company's complete line of fans, blowers, dust collectors and conveyors, fuel economizers. motors, engines, turbines, generating sets, forges, hot blast apparatus, etc. Principal dimensions and other information regarding the apparatus illustrated is given briefly.

FRANK MCHALE, 302 Havemeyer Building, New York City. Catalogue of books relating to engineering subjects, including chemistry, mining, mechanical, electrical and steam engineering, construction, hydraulics, etc. Books will be furnished at the lowest market prices and forwarded prepaid to any part of the world on receipt of advertised price.

BRUCE-MACBETH ENGINE Co., Cleveland, Ohio. Catalogue of Meriam vertical gas engines for electric lighting, pumping, and general power purposes. The catalogue illustrates the four-cylinder engine built in sizes from 75 to 300 horse-power, and shows the details of construction. The two-cylinder type is also illustrated, and the four-cylinder engine with a gas producer plant.

NORTHERN MACHINE & REPAIR WORKS, Wausau, Wis. Circular of the "Little Giant" cutting-off machine for cutting tool steel, mild steel, cast iron, brass and other metals. The machine is of simple construction, being designed for use in shops that do not require an elaborate equipment and where a cutting-off machine with hand feeds answers all practical requirements

H. W. CALDWELL & SON Co., Western Ave., 17th-18th St., Chicago, Ill. General catalogue No. 34, of hoisting, elevating, conveying and power transmitting machinery for flour mills, grain elevators, cottonseed oil mills, starch works, breweries, distilleries, malt houses, sugar refineries, cement works, phosphate works, tanneries, etc. The catalogue contains 847 pages, 6 x 9 inches.

OSCAR E. PERRIGO, 6 Beacon St., Boston, Mass. Circular outlining systematic methods in shop management and cost accounting, which Mr. Perrigo is prepared to install. He is a consulting and systematizing engineer who has given a great deal of attention to manufacturing methods and systems, and invites correspondence from officials having troubles with shop or office management.

DIAMOND MACHINE Co., Providence, R. I. Catalogue of grinding and polishing machinery, comprising floor grinding machines, motor-driven grinders, wet tool grinders, automatic face grinders, locomotive guide bar grinders, roll grinders, surface grinders, gun barrel machinery, internal grinders, lathe grinder attachments, drill grinders, polishing and buffing machines, polishing wheels, emery wheels, strapping machines, etc.

ROCKWELL FURNACE Co., 26 Cortlandt St., New York. Catalogue of forging, heating and welding furnaces. The catalogue has a novel trade-mark on the cover showing an animal known as "Go-Sum" which is said to be a cross between a hippopotamus and a grasshopper. The catalogue illustrates a large number of furnaces adapted for practically all classes of work in which portable or stationary furnaces are employed.

WELLS BROS. Co., Greenfield, Mass. Catalogue and price list of die holders principally designed for use on screw machines. The holder is firmly clutched in its forward movement and when not cutting the die is held by friction, thus doing away with the noise ordinarily noticeable on screw machines. The holders are adapted for the "Little Giant" adjustable dies which are of the same quality as the regular dies supplied by the company.

ELECTRIC CONTROLLER & MFG. Co., Cleveland, Ohio. Catalogue of lifting magnets, giving a list of users and illustrating the uses to which lifting magnets are put in steel mills and other plants where sheet metal, steel rails, scrap and other metals are handled in large quantities. The possibilities of the lifting magnet are startling. One illustration, for example, shows a magnet lifting a locomotive cylinder, the magnet being applied to the planed surface at the juncture between the two cylinders.

D. O. JAMES MFG. Co., Chicago, Ill. Catalogue D of speed-reducing transmission gears (see MACHINERY, August, 1908, for description), for spur, bevel, miter, internal, spiral and worm gearing. The speed-reducing gears are designed to transmit the power of electric motors and other high-speed apparatus, reducing the speed to that required for machine tools, centrifugal pumps, elevators, etc. The catalogue contains valuable data on gearing, tables of natural trigonometrical functions, diagrams of circular pitch gears, etc.

SKINNER CHUCK Co., New Britain, Conn. Catalogue of independent universal and combination lathe chucks, drill chucks, planer chucks, face-plate jaws, drill press vises and reamer stands. The catalogue contains 48 pages, is made up with rounded corners, and is perforated for a loose leaf binder. The construction of the new Skinner gear pattern drill chuck is illustrated in sectional views, and a phantom view is shown of the Skinner positive drive drill chuck. The catalogue is one that will be found of general interest by users of machine tools and accessories.

NEW JERSEY FOUNDRY & MACHINE Co., 90 West St., New York. Catalogue of overhead carrying devices comprising trolleys, hoists, cranes, buckets, cars and tracking, etc. The Newhall patent steel frame I-beam trolley is illustrated in combination with a differential hoist. Various other combinations are shown and examples of installations. The company builds jib cranes suitable for foundry shops and other places where a jib crane is profitably used. The catalogue will be found of general interest by those concerned with the problem of hoisting and conveying materials either in the shop or in the field.

KEARNEY & TRECKER Co., Milwaukee, Wis. Catalogue No. 17 of Milwaukee milling machines. The catalogue illustrates the construction of the Milwaukee miller and two views are reproduced with reference numbers in red, each part being named below. Details of con-

struction are illustrated, including a vertical section showing the flooded lubrication system which has made Milwaukee millers famous. The company manufactures universal milling machines in three sizes, plain milling machines in three sizes, and manufacturing milling machines in two sizes. All styles have single pulley drive, all-geared feeds, and flooded lubrication.

RELIANCE ELECTRIC & ENGINEERING Co., Cleveland, Ohio. Treatise on the crank shaper, describing the characteristics of the cone pulley drive, speed-box drive, and variable speed motor drive with particular reference to the Lincoln variable speed motor which gives an infinite number of running speeds throughout its range. The treatise which is sent free on request will be found of much general interest to designers and users of shapers. It gives valuable information not only regarding the power required to drive crank shapers under definite conditions of work, but also compares the productive efficiency of the belt-driven and motor-driven shaper.

DAVIS-BOURNONVILLE Co., 97 West St., New York. Pamphlet illustrating and describing the Davis-Bournonville oxy-acetylene apparatus which produces a flame having a temperature of about 6,300 degrees F. that can be used either for welding or for cutting metals. The oxy-acetylene torch is described as a "putting-on tool," which it is in fact, it being not only possible to weld together iron, steel, cast iron, brass, copper, platinum and other metals and to unite dissimilar metals but also to build up defective castings and other pieces wherein metal is required. As a cutting-off tool, the torch works with rapidity and efficiency, being one of the most rapid and practical devices known for cutting off steel sheet piling, beams and other heavy structural work.

HENDEY MACHINE Co., Torrington, Conn. Catalogue of an improved line of Lincoln milling machines. The Lincoln type milling machine is the standard manufacturing miller for armories, pistol factories, and other establishments where interchangeable parts are milled on a large scale. The company has developed this useful type of machine so that it is now being used successfully on operations which heretofore have been considered suitable for a knee type milling machine only. The catalogue illustrates the No. 8 Lincoln miller equipped with special table and chip pan; the same machine with high legs; improved Lincoln miller No. 5 with single and double spindles; and Nos. 4 and 2½ machines. All sizes are equipped with gear box giving twelve feed changes.

WATERBURY-FARREL FOUNDRY & MACHINE Co., Waterbury, Conn. General catalogue descriptive of all the lines of machinery built by the company, being a general reference book which briefly reviews the most prominent types of machines constructed. The catalogue comprises, rivet, bolt, and nut machinery, butt and hinge machinery, cartridge machinery, drop presses and hammers, screw presses, machinery for tubes and rods, hydraulic machinery, knuckle-joint press, special lathes, single-acting open-back presses, single-acting pillar presses, double-acting presses, shears and slitters, finishing machinery for sheet metal, mufflers and furnaces, wire-drawing machinery, eyelet machinery, gang slitting machines, etc. This catalogue is compiled in an attractive and interesting manner, making it a valuable work of reference as well as a catalogue of machinery in the various lines represented.

MANUFACTURERS' NOTES.

VAN DORN ELECTRIC & MFG Co., Cleveland, Ohio, has made Mr. A. N. Frecker sales manager. Mr. Frecker was for several years in the electric drill and grinder business in New York.

CINCINNATI IRON & STEEL Co., Cincinnati, Ohio, states that, owing to the heavy demand for the "Nugent" clutch, its machinery department is working full force day and night.

GENERAL ELECTRIC Co., Schenectady, N. Y., was awarded a grand prize at the Alaska-Yukon-Pacific Exposition for its exhibit of electrical apparatus and a completely furnished model apartment.

ROBBINS & MYERS Co., manufacturer of circular and desk fans, dynamos, motors, etc., has changed the location of its Chicago office from 48 West Jackson Boulevard to 501-515 West Jackson Boulevard.

KEUFFEL & ESSER Co., Hoboken, N. J., maker of drawing, mathematical and surveying instruments, measuring tapes, etc., was awarded the grand prize for its exhibit at the Alaska-Yukon-Pacific Exposition at Seattle.

GENERAL ELECTRIC Co., Schenectady, N. Y., and J. A. Roebling Sons Co., Trenton, N. J., were awarded the grand prize at the Alaska-Yukon-Pacific Exposition for their exhibit of insulated wire and cable.

ROCKFORD LATHE & DRILL Co., Rockford, Ill., succeeds the Rockford Machine & Shuttle Co. A. Floburg is president; W. B. Johnson, vice-president and superintendent, and Charles Holmquist, secretary and treasurer.

HILL CLUTCH Co., Cleveland, Ohio, manufacturer of power transmission machinery, announces the appointment of Mr. G. W. Hoffman as sales engineer in charge of its Chicago office, located at 610 Marquette Building.

VARIABLE SPEED CLUTCH Co., Milwaukee, Wis., has opened a New York office at 50 Church St., Hudson Terminal Building, with Mr. W. L. Tenney, manager. Mr. Tenney was formerly with the Standard Heater Co., New York.

WARNER & SWASEY Co., Cleveland, Ohio, recently opened an office in Detroit, located in the new Ford Building. Mr. Thomas Farmer, who has for several years represented the Warner & Swasey Co. in the Detroit territory, will be manager of the new office.

SPRINGFIELD MFG. Co., Bridgeport, Conn., maker of special grinding machines and emery wheels, has been purchased by H. F. Brandes, former superintendent of the Bullard Machine Tool Co., Bridgeport, Conn. Mr. George W. Jackman, former owner, has retired.

LAKESIDE FORGE & WRENCH Co., Springfield, Mass., has acquired the plant of the Springfield Drop Forge Co., Springfield, which again began operations with a full force of men September 27. Mr. Eugene Childs, formerly connected with the Trimont Mfg. Co., Roxbury, Mass., is general manager and president of the company.

WARNER & SWASEY Co., Cleveland, Ohio, is building a large addition to its new plant which was partly completed before the late depression in business. The addition is a single story steel and concrete structure and is equipped with electric traveling cranes and other modern features. It will be completed about December 1.

JOSEPH T. RYERSON & SON, Chicago, Ill., are reported to be contemplating entering the field of machine tool manufacture, and negotiations have been made for a suitable location in Cincinnati on which to erect a large plant The concern now is known as a manufacturer and distributer of boiler shop machinery and other iron-working tools.

LYON METALLIC MFG. Co., Aurora, Ill., has established an eastern branch with office at 1365 Hudson Terminal Building, New York. The concern manufactures a complete line of steel factory equipment, including lockers, racks, tables, etc., and its rapidly-growing business has made an eastern branch necessary. Mr. B. L. Waters, secretary of the company, is in charge of the eastern branch.

BAY STATE MACHINE Co., Erie, Pa., is the name of a concern newly organized to manufacture marine engines. The new company has bought the charter of the old company of the same name. The officers are John E. Waitz, president; Joseph Crawford, treasurer and manager; L. E. Safford, vice-president and sales manager; and Charles Boring, superintendent.

GENERAL ELECTRIC Co., Schenectady, N. Y., states that there is a large demand for its tantalum lamps, which because of their excellent life service and efficiency make a considerable economy in incandescent lighting possible. The life of a tantalum lamp will average about 600 hours. It can be used on an alternating current of 50 cycles or less.

LITHOPRINT Co., 41-43 Warren St., New York, is prepared to make black prints on white ground, absolutely true to scale, on any kind of paper including any drawing paper, bristol board or tracing cloth. The prints undergo neither water nor acid bath so are unchanged in scale. They are made as quickly as blue-prints, and are said to be superior to any blue-print in quality and finish.

SOCIÉTÉ FRANCAISE DES ROULEMENTS A BILLES, manufacturer of the RBF ball bearings, announces that Lavalette & Co. are no longer its representatives in the United States. The International Engineering Co., 1779 Broadway, is now the sole and exclusive agent for the sale of RBF ball bearings in America, and all inquiries should be addressed to it in the future.

S. A. WOODS MACHINE Co., Boston, Mass., manufacturer of wood planers, has taken Mr. W. S. Howe, formerly advertising manager in charge of the small tool sales department of the Canadian-Fairbanks Co., Ltd., Montreal, Canada, into its employ. The S. A. Woods Machine Co. has reduced its line of wood-working machinery to planers and molders, on which it now specializes.

B. F. STURTEVANT Co., Hyde Park, Mass., has established a savings bank life insurance agency at its works in charge of an instructor furnished by the savings insurance committee of the Boston Chamber of Commerce. This agency is established under the Massachusetts law which became operative November 1, 1907, permitting any savings bank to operate a department for issuing life insurance policies and old-age annuities.

DEPARTMENT OF COMMERCE AND LABOR, Bureau of the Census, Washington, D. C., has fixed on November 3 as the date for examining applicants for appointments as special agents for the collection of the 13th census of manufactures, mines and quarries. The circular lists the cities in the various States in which the examinations will be held and gives the requirements of the applicants and the rate of compensation for the work.

S. OBERMAYER Co., Cincinnati, Chicago, and Pittsburg, has placed a new foundry product on the market called "Bulldog" core wash. It is so called because of its adhesive qualities. Foundries using it have no troubles from the core wash burning or peeling off. The largest castings can be made with cores washed with the new preparation with no troubles from the iron sticking to the sand, and come out of the mold with clean, smooth surfaces.

SHEFFIELD GAS POWER Co., Kansas City, Mo., has acquired the entire assets, factory and good will of the Weber Gas Engine Co., at a bankruptcy sale. The factory has been in continuous operation throughout the receivership term and is being continued in full operation by the present owners. The management of the business is in entirely new hands; George M. Hawes is president; Freeman Field, vice-president and treasurer; and W. H. Spiller, assistant manager.

WARREN WEBSTER & Co., Camden, N. J., state that the patent decision in the case of Warren Webster & Co. *vs.* C. A. Dunham Co., mentioned in the October number, does not refer to about one hundred existing patents under which Warren Webster & Co. operate. The patent in this case expired over a year ago, and the suit merely involved a case of liability for damages on the part of the defendant. There are now pending in the Federal courts suits against users of the Dunham apparatus for infringement on patents which have not expired.

INTERNATIONAL ACHESON GRAPHITE Co., Niagara Falls, N. Y., is adding a substantial and commodious addition to its Niagara Falls, Ontario, works. The structure is to be 50 x 105 feet and the contract has been awarded to W. S. Homan, Niagara Falls, Ontario. The facilities afforded by this addition will make the Canadian works of the company quite complete and enable them to care for a rapidly growing Canadian trade. The building will contain a new grinding plant in which the lubricating, electrotyping and other grades of graphite will be prepared for the market.

MUSEUM OF SAFETY AND SANITATION, 29 West 39th St., New York, announces that a prize of 2,500 kronen ($612) was offered by Dr. Louis L. Seaman while at the XVI International Medical Congress, in Budapest, in September, for the best paper on the subject: "What should be the Status of the Medical Department of an Army in order that its Sanitation and Hygienic Conditions may be maintained at the Highest Efficiency so that in the Emergency of Battle its Units may best respond to the Call of its Commanders?" The award of the prize will be made by the executive committee of the XVII International Medical Congress.

DODGE MFG. Co., Mishawaka, Ind., lays claim to having the largest plant in the world for the manufacture of machinery for the mechanical transmission of power. Its buildings cover nearly 40 acres in a 60-acre plot on the Lake Shore & Michigan Southern Railway. In it there are annually worked up 2,000 tons of pig iron, 7,000,000 feet of lumber, 900 tons of steel and structural iron, 6,200 tons of steel shafting and 9,000 tons of coal. The resulting production is 250,000 "Independence" wood-split pulleys, 100,000 Dodge standard iron pulleys, 90,000 solid iron pulleys, 95,000 hangers, 150,000 bearings of all types, 4,000 friction clutches and over 2,000,000 pounds of bearing metal.

ROBERTSON DRILL & TOOL Co., Buffalo, N. Y., has moved from 1848 Niagara St., to its factory, corner of Grant and Letchworth Sts. The new building is of brick, two stories high with basement of concrete construction, the length being 150 feet and the width 50 feet. The basement is used for storage and a heating plant. The ground floor is the machine shop for the manufacture of its drill presses and power hack saws. The machinery is driven by a 30-horse-power electric motor, and the shop is equipped throughout with new tools. The office is at the east end of the factory, and the top floor is used for pattern making, etc. The foundry is adjacent to the new building to the north about 50 feet, and is equipped with modern foundry appliances including an electric crane. The anticipated output of the new plant is about twenty-five drills per day.

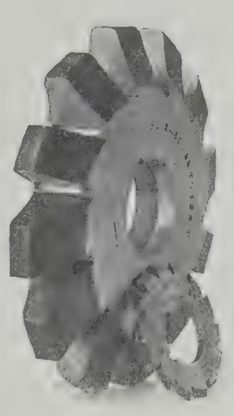
DAVIS-BOURNONVILLE Co., 97 West St., New York, has lately performed some interesting repairs with the oxy-acetylene apparatus. Among the repairs made are the following: A cracked kettle weighing two tons, thickness varying from 5 inches at the bottom to 3 inches at the rim was successfully welded. The crack was 18 or 19 inches long. A 15 ton gear wheel made in two sections was cracked through the rim which was about 22 inches wide. The rim was welded and one tooth 22 inches wide and 6 inches high was built up, machined to shape and made as serviceable as the original. The apparatus was used very successfully by a railroad company for cutting up old steam boilers. It is generally known that the cost of scrapping steam boilers is very heavy in comparison to the value of the scrap material. The apparatus did the work rapidly and at a comparatively low cost. Several other repairs were lately made,

B·S

OF ACCURATE GEARS

Cutting Machines using B & S Cutters.

Cutters Made From Original Curves



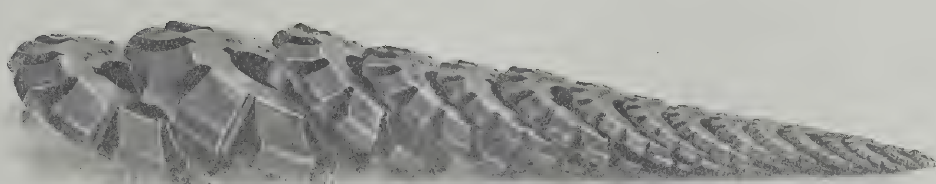
were first introduced by J. R. Brown & Sharpe over 40 years ago. The system originated at that time has been continued and developed until **B & S Original Curves** have become **recognized** as **standards** in modern gearing practice.

The forms are carefully laid out and maintained, the cutters being as nearly exact copies as expert mechanical skill, aided by special machines, can make them.

The sides of the cutter teeth are exact duplicates, and their curves are carefully tested before the cutter is placed in stock. The teeth run true with the hole and are proportioned to give ample clearance for chips. Hardening and tempering are given especial attention; hence the great durability and remarkable uniformity of each successive lot of cutters.

All ordinary pitches are carried in stock and special cutters can be quickly made to order.

CORRESPONDENCE SOLICITED



PROVIDENCE, R. I., U. S. A.

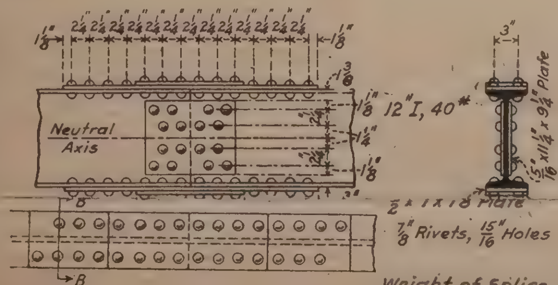
B·S

CONTENTS FOR NOVEMBER

including welding steam dryer pipes, fly wheel spokes, broken hydraulic press platen, smoke-box heaters, cast steel water pipe tee 20 inches in diameter, etc.

MISCELLANEOUS

y A. L. Campbell



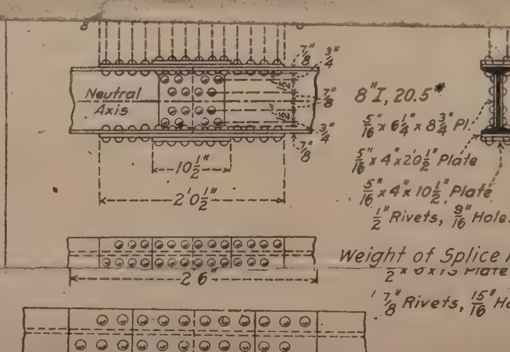
Bending efficiency of splice:

Rivets,	104 %
Net section of beam,	80.7%

Efficiency of splice for direct tension:

Weight of Splice Plates
183 pounds.

A. L. Campbell



Net section of beam, 82.6%

Efficiency of splice for direct tension:

Rivets,	82.2%
Net section of beam,	88.8%
Net section of splice plates,	100 %

Weight of Splice Plates
108 pounds.

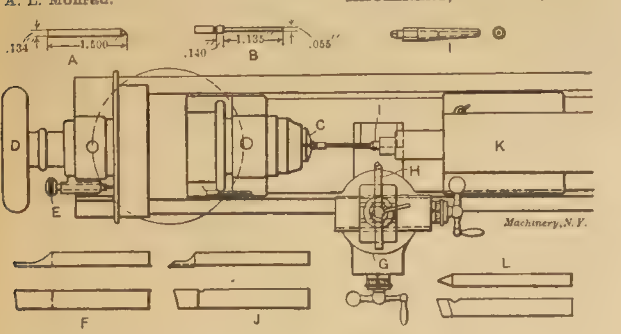
ustrial Press, New York

Supplement to RAILWAY MACHINERY, November, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Jig and Die Work in the Bench Lathe—I"

SHOP OPERATION SHEET NO. 115.

A. L. Monrad. MACHINERY, November, 1909.



Accurate Turning in a Bench Lathe.

1. As the pin is to be turned to the dimensions given at *B*, secure a piece of say 0.134-inch wire which is the size of Stub's gage number 29. Insert split chuck *C* for this size wire in the lathe spindle, being careful that the tapering part of both chuck and spindle are clean. Push the wire through the chuck until it projects about 1⅝ inch, and tighten the chuck by turning the hand-wheel *D*.

NOTE.—Never use the indexing pin *E* in the holes of the pulley to prevent the latter from turning while tightening the chuck (unless a special index plate is used for that purpose) as by so doing the indexing holes will become worn.

2. If the wire extends far beyond the hand-wheel *D*, place a horse beneath the end of the wire to keep it from flying about when turning, or saw it off close to the lathe spindle.

3. Fasten a cutting-off tool *F* in the tool-post with the point as close as possible to the latter to prevent chattering. Set the tool so that it will cut off 1½ inch of stock, and with the belt on the smallest pulley and the foot on the treadle giving the slowest speed, cut the wire, using lard oil as a lubricant.

NOTE.—If a number of pieces are to be cut off, the tail center can be used as a stop for the stock by locating it 1½ inch from the cutting edge of the tool.

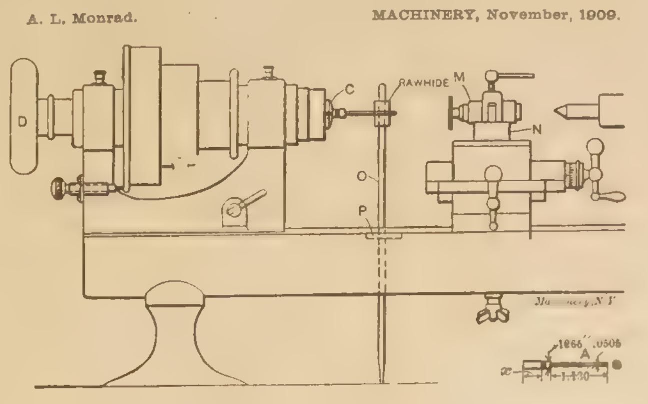
4. Set the slide rest *G* to an angel of 30 degrees, and fasten the piece of wire, previously cut off, into the chuck so that its end projects about ¼ inch. Set the cutting edge of a diamond pointed tool *H* to the height of the center of the work and turn the latter to a conical point as shown at *A*. Allow the wire to project about 1 5/16 inch beyond the face of the chuck and support it by a special female center *I* in the tail-stock *K*.

5. Rough turn the pin, using the diamond point tool *H*. Take a finishing cut with a side tool *J*, forming the pin as shown at *B*, and making it 0.055 inch in diameter and 1.135 inch long to the shoulder. When turning, shift the belt to the largest pulley and press down with the foot on the fast treadle. Cut a groove 0.140 inch from the shoulder with a sharp thread tool *L*.

6. After the pin has been hardened, polish it in the lathe, using a medium grade of emery cloth, and then draw the temper to a light straw color. Again polish the pin ready for the grinding operation.

SHOP OPERATION SHEET NO. 116.

A. L. Monrad. MACHINERY, November, 1909.



Grinding in a Bench Lathe

1. After the pin is turned and hardened as described in the preceding sheet, grind off the conical point by hand on an emery wheel making the distance from the end to the shoulder 0.130 inch as shown at *A*. Insert a chuck the proper size for the small diameter of the pin in the head-stock spindle.

2. Insert the small end of the pin in the chuck within 1/16 inch of the shoulder and tighten the chuck slightly by turning the handle *D*. If the work is gripped too tightly, it is liable to run out of true.

3. Fasten the grinding attachment *M* in the tool-post so that the axis of the wheel spindle is parallel with the axis of the work, and also so that the two axes are in the same horizontal plane. Adjustments for height may be obtained by inserting a ring *N* beneath the attachment. Dress the face of the wheel, which should be of fine carborundum, to an angle of about 5 degrees. Cover the slide rest with a piece of cloth to protect the bearings from the abrasive when grinding, and grind the part *x* of the pin perfectly true.

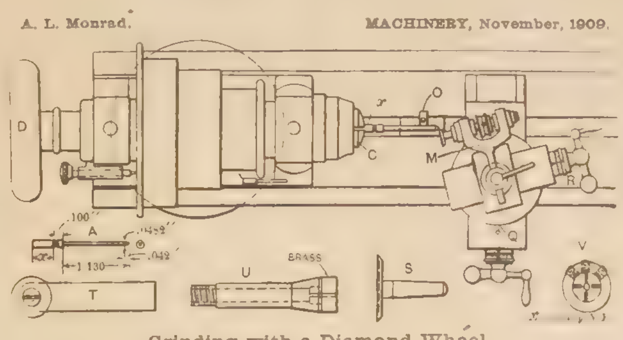
4. Place a larger chuck *C* in the spindle and reverse the pin, gripping it by the part just ground. If the outer end of the pin runs out it may be trued by inserting a narrow strip of tissue paper between the taper of the chuck and the spindle.

5. The steady-rest *O* is next adjusted to the work. This must be done very carefully so as not to spring the pin when grinding. First move the brass plate *P* up between the ways of the lathe bed, and then adjust the rawhide support until it is in line with the work. Next stick the wire point into the bench, as shown in the illustration, so that the rawhide just barely touches the pin.

6. Grind the pin up to the shoulder to a diameter of 0.0505 inch, allowing 0.0005 for lapping. Be sure that the work is parallel before taking the finishing cut. Keep the wheel sharp and run with the belt on the second pulley and the foot on the fast treadle. Feed moderately, grinding off 0.001 inch at a time. Grind the head to a diameter of 0.1265 inch. Allow the steady rest to remain in position for the succeeding operation.

SHOP OPERATION SHEET NO. 117.

A. L. Monrad. MACHINERY, November, 1909.



Grinding with a Diamond Wheel

1. Loosen the screws in the slide rest and swing it around to an angle of 4 degrees, using the graduations at *Q*.

2. Grind the end of the pin true, and then set the feed-screw thimble *R* to zero. Next grind a taper on the end 0.042 inch long and 0.049 inch diameter.

3. Remove the emery wheel from the tool-post grinder, drive a diamond wheel *S* in the grinder collet and screw it into the spindle. The spindle should be driven direct from the main shaft, using the smallest pulley, to obtain the slowest speed. Distribute some number 2 diamond dust mixed with sperm oil over the face and side of the wheel and then charge the latter by holding a hardened roller *T* against its face and side for say five minutes.

4. Change the belts so that the grinder runs at the fastest speed while the pin revolves very slowly, and finish grind the end of the pin. Set the thimble *R* on the feed-screw to zero, and grind the taper end to 0.0482 inch diameter at the largest part, as shown at *A*, leaving a sharp corner and a shoulder which is to be 0.001 inch on a side after the work is finished by lapping.

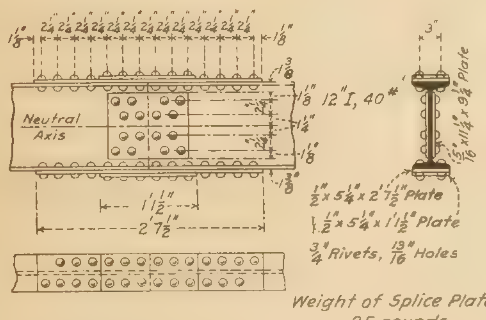
5. Move the slide rest and the steady rest *O* to one side, and with a lap *V*, lap the two diameters of the pin to 0.050 and 0.126 inch, respectively, using the finest emery and sperm oil. To lap the pin round and straight, do not move the lap slowly, but draw it back and forth moderately fast, for by so doing a perfectly straight and round surface is obtained. Finish with a clean lap and use machinery oil for draw-lapping to obtain a very brilliant and shining surface. Move the slide rest back in position, and with the hand resting on the slide rest, draw-lap the taper of the pin, using a flat copper lap and fine emery, or white oil-stone dust and sperm oil until it is reduced to 0.048 inch at the largest part.

6. Reverse the pin in the chuck so that the end *x* projects, and break off this end. Insert a chuck *U*, to which a brass piece has been soldered, in the spindle. Drill and bore a hole, in which the small part of the pin will be a push fit, in this brass piece, and push the pin through the plate. Solder the pin to the plate. Replace the diamond wheel with an emery wheel and adjust the latter until its axis is in the same plane and at right angles with that of the work. Face the head of the pin to a length of 0.100. With a side tool remove the solder and withdraw the pin.

II.—SPLICES FOR I-BEAMS

Contributed by A. L. Campbell

Splice for 12 inch-40 pound I beam.

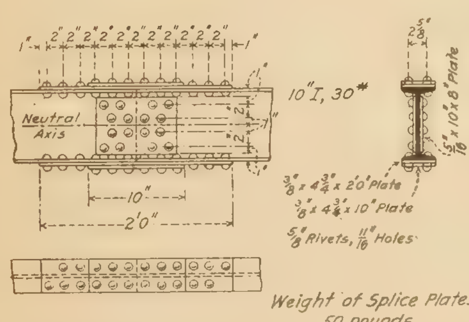


Weight of Splice Plates 85 pounds.

Bending efficiency of splice:
- Rivets, .104%
- Net section of beam, 80.7%

Efficiency of splice for direct tension:
- Rivets, 89.7%
- Net section of beam, 86.7%
- Net section of splice plates, 95.4%

Splice for 10 inch-30 pound I-beam.



Weight of Splice Plates 50 pounds.

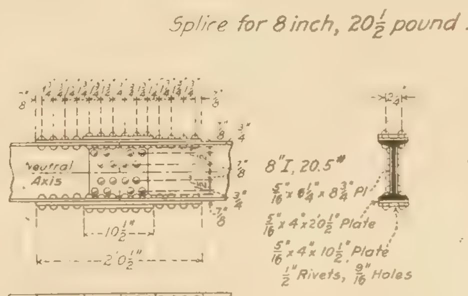
Bending efficiency of splice:
- Rivets, 89.1%
- Net section of beam, 84.5%

Efficiency of splice for direct tension:
- Rivets, 79.2%
- Net section of beam, 89.8%
- Net section of splice plates 96.4%

I.—SPLICES FOR I-BEAMS

Contributed by A. L. Campbell

Splice for 8 inch, 20½ pound I-beam.

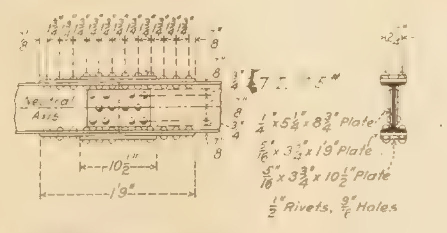


Weight of Splice Plates 35 pounds.

Bending efficiency of splice:
- Rivets, 81%
- Net section of beam, 82.6%

Efficiency of splice for direct tension:
- Rivets, 82.2%
- Net section of beam, 88.8%
- Net section of splice plates, 100%

Splice for 7 inch, 17.5 pound I-beam.

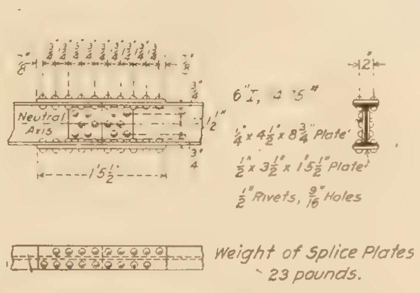


Weight of Splice Plates 26 pounds

Bending efficiency of splice:
- Rivets, 92.3%
- Net section of beam, 82.8%

Efficiency of splice for direct tension:
- Rivets, 78%
- Net section of beam, 88.4%
- Net section of splice plates, 89.7%

Splice for 6 inch, 14¾ pound I-beam.



Weight of Splice Plates 23 pounds.

Bending efficiency of splice.
- Rivets, 83.3%
- Net section of beam, 89%

Efficiency of splice for direct tension:
- Rivets, 81.3%
- Net section of beam, 87.8%
- Net section of splice plates, 91.5%

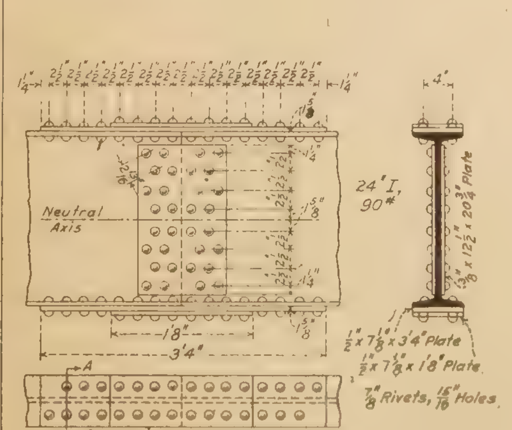
Supplement to RAILWAY MACHINERY, November, 1909

Data and Diagrams for the Article in this number entitled "Splices for I-Beams and Channels"

IV.—SPLICES FOR I-BEAMS

Contributed by A. L. Campbell

Splice for 24 inch, 90 pound I-beam.

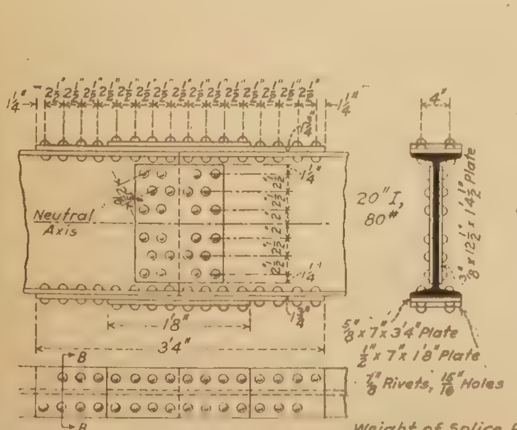


Weight of Splice Plates 177 pounds.

Bending efficiency of splice:
- Rivets, 85.4%
- Net section of beam, 85.2%

Efficiency of splice for direct tension:
- Rivets, 83.7%
- Net section of beam, 91.2%
- Net section of splice plates, 82.4%

Splice for 20 inch, 80 pound I-beam.



Weight of Splice Plates 183 pounds.

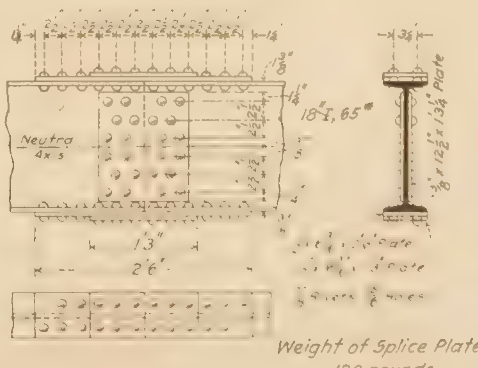
Bending efficiency of splice:
- Rivets, 90%
- Net section of beam 82.8%

Efficiency of splice for direct tension:
- Rivets, 80.7%
- Net section of beam, 88.8%
- Net section of splice plates, 86.7%

III.—SPLICES FOR I-BEAMS

Contributed by A. L. Campbell

Splice for 18 inch, 65 pound I-beam.

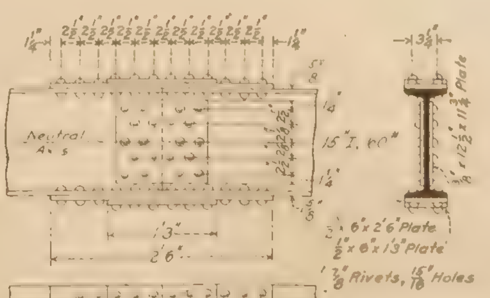


Weight of Splice Plates 120 pounds.

Bending efficiency of splice:
- Rivets, 93.6%
- Net section of beam, 84.2%

Efficiency of splice for direct tension:
- Rivets, [illegible]
- Net section of beam, [illegible]
- Net section of splice plates, [illegible]

Splice for 15 inch, 60 pound I-beam.



Weight of Splice Plates 108 pounds.

Bending efficiency of splice
- Rivets, [illegible]
- Net section of beam, [illegible]

Efficiency of splice for direct tension:
- Rivets, [illegible]
- Net section of beam, [illegible]
- Net section of splice plates, 83.2%

RAILWAY MACHINERY

A special edition of MACHINERY devoted to Locomotive and Car Equipment and Mechanics

December, 1909

ELECTRIC LOCOMOTIVES FOR THE P. R. R. TUNNELS*

An electric locomotive which incorporates many novel features in its design, and is the result of several years of cooperative development between the Pennsylvania Railroad and the Westinghouse Electric and Manufacturing Company, is shown in the engraving, Fig. 1. This is the first locomotive of an initial order for twenty-four, which are to be used for hauling trains through the Pennsylvania tunnels. At present it is in operation on the electrified tracks of the Long Island Railroad. It is distinctly a high-powered machine built for high-speed operation.

In the wheel arrangement, weight distribution, trucks, and general character of the running gear, it is the practical equivalent of two American type locomotives coupled permanently back to back. The motors are mounted upon the frame and are connected through jackshafts to the driving wheels by a system of cranks and parallel connecting-rods, similar to steam practice. A view of the chassis is shown in Fig. 2. The connecting-rods are all rotating links between rotating elements, and are thus perfectly counterbalanced for all speeds. The employment of this transmission permits the mounting of the motors upon the frame, which are thus spring supported. In addition, the center of gravity is raised to approximately the same height above the rails, as has been found desirable for high-speed steam locomotive practice.

The same freedom of motion in the wheels and axles that is characteristic of the present steam locomotive is also obviously secured. These locomotives differ, however, from those driven by steam in that the variable pressure of the unbalanced piston of the latter is replaced by the constant torque and constant rotating effort from the motors; consequently the pull upon the draw-bar is constant and uniform. It might appear to the casual observer that by this arrangement of driving a return has been made to steam locomotive practice as regards counterbalancing difficulties, but it will be seen upon examination that this is not true. There are no unbalanced reciprocating weights, as all weights are revolving ones and directly counterbalanced, so that as far as pounding upon the track is concerned, the effect is precisely the same as though the whole were driven without any pins or rods.

The starting requirements of this locomotive are unusually severe, as it will be called upon to start a train of 550 tons trailing load on the tunnel grades under the river, which are approximately two per cent. The guaranteed tractive effort of 60,000 pounds is amply within the capacity of the electrical equipment. The normal speed with load upon a level track is 60 miles an hour, but the locomotive is capable of a speed much in excess of this. The total weight of the locomotive is 332,100 pounds, of which 208,000 pounds is carried by the drivers. At maximum capacity, this locomotive develops 4,000 horse-power. For sustained heavy output, the motors are designed for forced ventilation, but the initial service will not require this provision.

Fig. 1. One of the Ganz Type of Electric Locomotives which is to be used in the Pennsylvania Tunnels

It will be seen by referring to the illustrations that the locomotive is an articulated machine. Each half carries its own motor and has four driving wheels 68 inches in diameter and one four-wheel swing bolster swivel truck with 36-inch wheels. Each section has its own cab of sheet steel extending the length of the frame. Communication between the two cabs is provided by a standard Pullman vestibule. The rigid wheel base of each half is 7 feet 2 inches, and the total wheel base of each half is 23 feet 1 inch while that of the whole locomotive is 55 feet 11 inches. The total length of the locomotive inside of knuckles is 64 feet 11 inches.

The running gear and mechanical parts were built by the Pennsylvania Railroad at its Juniata shops at Altoona. The air brake equipment was built by the Westinghouse Air Brake Company, and the electrical equipment was built and the apparatus assembled by the Westinghouse Electric and Manufacturing Company at their East Pittsburg works

Frames

The locomotive frames are of cast steel of large cross section and massive construction. In their design an unusually

* For a detailed description of a Ganz three-phase locomotive, see RAILWAY MACHINERY, September, 1909.

large factor of safety has been employed. The side frames are of sufficient strength to allow the engine to be raised by jacks applied at fixed points provided in the construction. The upper surfaces of the side frames are especially broad and furnish bases for the feet of the motor frames, which fit over the top members of the side frames with heavy flanges.

There are five heavy cross-ties extending from side frame to side frame, consisting of bumper, articulation and jackshaft girders, body bolster, and drive wheel cross-tie. Additional transverse strength is given by the steel motor frame which is bolted to the side frames as elsewhere described. The bumper and articulation girders are so proportioned that a bump equivalent to a static load of 500,000 pounds (150,000 pounds applied on center line of draft cylinder and 350,000 pounds applied on center line of platform buffer) will produce no stress exceeding 12,000 pounds per square inch in the frames. The jackshaft girder is of inverted U-section and it is arranged to give rigid support to the jackshaft bearing brasses. It also carries upon facings, the driver brake cylinder and the brake lever fulcrum which is integral with the girder. The cross-tie between driving wheels is of diagonal design, especially fitted for stiffening the bottom members, and also providing a base for the front driver-brake hanger-pin. This tie fits between the upper and lower members of the side frames and assists in rigidly supporting the heel of the motor frame. The articulation girder is unusually rigid diagonally in the horizontal plane, and it is designed to accommodate the articulation gear details. The body bolster carries the swivel truck center-pin and it is of ample strength to withstand all braking strains.

Wheels

The driving wheels are 68 inches in diameter and are fitted with rolled steel tires 3 inches thick; they have cast steel centers and are fitted with retaining rings. The driving wheel centers are fitted with quartered crank-pins and counterbalances; these latter are offset from direct opposition to the cranks to correct the transverse unbalance that would otherwise exist. The truck wheels are of rolled steel 36 inches in diameter.

Axles, Shafts and Cranks

The axles, jackshafts and motor shafts are of special carbon steel, oil-tempered and annealed. They are of large diameter, finished all over and each has an axial hole throughout.

The motor shaft cranks are forged with integral counterbalances. They are accurately located in quartering positions and press-fitted and keyed to the shaft. The jackshaft cranks are forged integrally with the shaft in a quartering position. Their counterbalances are keyed in position. As with the driving wheels, the counterbalances of motor shafts and jackshafts are offset from direct opposition to the cranks in order to complete the balance. All crank-pins are of special carbon steel, oil-tempered and annealed; they are of ample diameter and are bored axially and press-fitted to their respective cranks and wheels.

Connecting-rods

All connecting-rods are of special carbon steel, oil-tempered and annealed.

Inasmuch as under the action of the brake shoes, the wear of the axles and the take-up of the wedges in the pedestals tend to decrease the distance between the axles and the jackshaft, the main rod is adjustable at each end and is so fitted that all take-up shortens the rod and furnishes compensation. The type of adjustable head is that employed on Pennsylvania Railroad class E-3 locomotives. All other rods are fitted with solid bushed ends.

Draft-gear and Articulation Details

The bumper ends of the locomotive are fitted with Westinghouse friction draft-gear, standard M. C. B. couplers, and platform buffers of Pennsylvania Railroad standard type.

The articulation ends are fitted with permanent couplings of long twin draw bars and Westinghouse friction draft-gears so designed that the leading half serves as a leading truck and the other half as a trailer in whatever direction the locomotive may be moving. The coupling gear is so designed as to oppose any possible "nosing" tendency or buckling action of the halves.

Materials

All materials of the locomotive running gear were furnished under Pennsylvania Railroad standard specifications with the exception that the axles, shafts, rods and crank-pins are of special carbon steel, oil-tempered and annealed, and were subject to special inspection.

Cabs

The cab of each half is an independent structure, complete in itself, and so constructed that it may be lifted bodily from the running gear with the floor and all auxiliary apparatus and set upon any convenient flat surface or trestle support without damage, leaving the motor and running gear accessible for any desired overhauling and permitting attention to be given at the same time to the machinery in the cab. As before stated, the cabs are identical in construction and fittings, are amply lighted by electric lamps, and so arranged that they are interchangeable. The location of the cabs in assembling is determined by dowels fitting in corresponding holes in the running gear, and they are held in place by bolts. Bulk-heads with doors are so arranged that the motor and air compressor compartments, containing nearly all of the auxiliary apparatus, may remain lighted at all times with no intrusion of light in the controller compartment to affect the vision of the driving engineer. Provision is to be made for heating the cabs by steam furnished from electric steam boilers within the cabs. Steps and hand rails necessary for safe and convenient access to all parts of the locomotive are provided. Each cab is fitted with an appropriate bell for hand operation, a chime whistle, a sand-box and sanders, and also with an overhead collector of the pantagraph type, which is located on the roof; this is used for obtaining a power supply when passing over gaps in the third rail in yards. The sanders and overhead collectors are operated by foot push-buttons

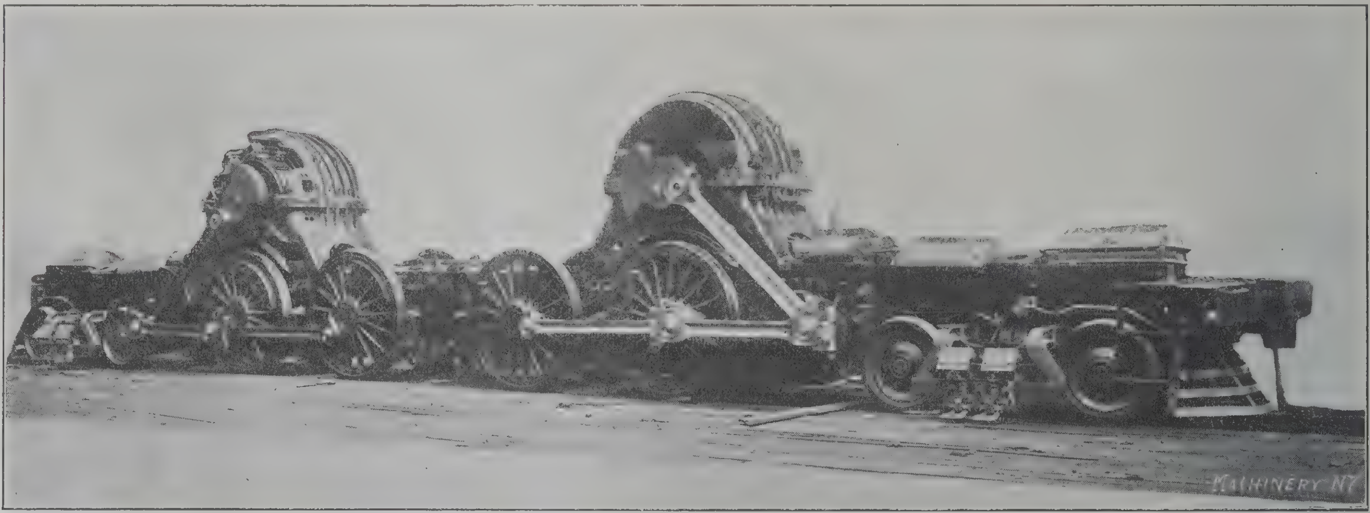


Fig. 2. View of the Chassis of the Electric Locomotive, showing the Motors and the Way they are connected with the Driving Wheels

located near the master controller and within easy reach of the driving engineer.

Headlights

Each cab carries on its own roof, at the end, an electric headlight having for its illuminating element a 50-candle-power stereopticon lamp operated from the main current, with suitable resistances, on 240 volts. These headlights are not intended to be of high candle power, or to be as powerful as a searchlight, although they might readily have been made so, as, obviously, the electric current is at hand. It was considered of great importance to avoid the blinding effect on the motorman of a powerful light, as signals with color indication only are provided in the tunnels and terminal yard.

Air Brakes

Each half of the locomotive is supplied with complete Westinghouse air brake equipment actuated by a motor-driven air compressor and a 600-volt motor, for both automatic and direct braking of locomotive and train. The compressor also furnishes air for the electro-pneumatic switches, and its displacement is 65 cubic feet of free air per minute. The entire system is especially designed for these locomotives. The brake rigging is suitably proportioned for the weights and it is arranged to deliver a braking power of 85 per cent at 50 pounds cylinder pressure.

Electric Equipment

The motive power of this type of locomotive is delivered from two interpole motors operating on direct current at 600 volts. The design of these motors was governed by the necessity of commutating the heavy drafts of power required to accelerate the heavy trains on the tunnel grades. For this purpose the design not only affords great electrical stability, but renders it possible to use the economical flexible and efficient field control. Each motor will develop 2,000 horsepower on a current of 2,900 amperes at 600 volts. The weight of each motor complete without crank is 42,000 pounds.

The motor frames are cast steel shells divided horizontally and bolted rigidly together. The motor is of open construction, affording easy access to all parts. It is especially provided with powerful self-ventilation. If the full power of the locomotive is to be used more frequently than contemplated, ventilation by air blast can be used to greatly increase the output. Semi-circular openings in the lower half of the frame provide seats in which the bearing housings are rigidly bolted. The lower half of the frame is provided with four feet for mounting and bolting on the side frames of the running gear, and these feet have machined flanges fitting over the top members on the side frames and stiffening the structure against transverse movement. In addition to being securely bolted, the feet of the frame are firmly wedged in place.

The field of the motors has ten main poles and ten interpoles, with heavy strap field windings. The main field is split in halves, both of which are used in slow-speed operation. One of these sections is shunted in control.

The armature core is built of soft steel punchings assembled with the commutator. The commutator bars are of hard drawn copper clamped by cast steel rings over mica insulation.

For relief of the driving mechanism from excessive strains in the event of short-circuit in the powerful motors, an adjustable friction clutch of novel design and tested efficiency in action is provided between the armature spider and the motor shaft.

Each half unit is supplied with two pairs of rail shoes of appropriate size and strength, suitably connected and fused. One pair of shoes is mounted on a hardwood beam on each side of the swivel or four-wheeled truck.

Control

The control of these powerful motors is of Westinghouse shunted field type, and by utilization of the unit switch system the motors may be grouped in "series" or in "multiple" at will. Electro-pneumatic switches, actuated by air from the brake compressor and operated by magnets controlled from the master controller, are provided to regulate the field strength of the motors by shunting and by cutting out a portion of the field winding, in addition to the "series-parallel" grouping, thus giving increased economy of operation and additional running points, greatly improving the facility and economy of operation. The bridging system is used for passing from series to multiple connections. The motor fields are arranged to be reversed for changing the direction of motion, and reversing is accomplished by unit switches. The master controller is simple in operation, and the cab is so arranged that the entire controlling mechanism of the locomotive and train is within reach of the driving engineer. While it is not intended that the half units be operated independently, the cabs are identically equipped and the windings, connections and control are such that in the event of the disabling of one motor, the train may be operated under reduced power by the second motor, the same resistances being employed as for the two.

A master controller with latched handle and suitable operating points is placed in each end of the locomotive and the circuits thereto are so arranged that when two or more locomotives are coupled together all may be operated simultaneously from any one of the master controllers. All switches are operated from the master controller entirely at the will of the motorman or engine driver.

The resistances are of the three-point cast grid type. The grids have such capacity that when one motor is cut out of service the locomotive will operate with the remaining motor. Under such circumstances the locomotive will exert a tractive effort of 25,000 pounds with the train accelerating at a rate of one-tenth mile per hour per second, until the resistance grids are cut out.

Suitable receptacles and jumpers are provided to establish the necessary low voltage control circuits between the locomotive half units.

A duplicate set of small storage batteries is supplied in each half unit for the operation of the control circuits, and relays with suitable resistances are provided for shunting part of the current of the compressor motor through the batteries for automatic charging.

An exceptionally quick-acting circuit-breaker is supplied on each half unit, which is connected between the junction of the third rail shoe and overhead collector cables and the switch groups. The main switch is on the line side of the circuit-breaker.

The general specifications for the principal parts of these locomotives are as follows:

Total weight	166 tons
Weight of electrical parts	62 tons
Weight of mechanical parts	103 tons
Maximum horse-power	4,000
Tractive effort	60,000
Diameter driving wheels	68 inches
Diameter truck wheels	36 inches
Rigid wheel base, each half	7 feet 2 inches
Total wheel base, each half	23 feet 1 inch
Total wheel base	55 feet 11 inches
Total length of locomotive	64 feet 11 inches

* * *

The air pump exhaust pipes of about one hundred and fifty locomotives of the Lehigh Valley Railroad have been changed, so that the pumps now exhaust directly into the atmosphere instead of into the smoke-box, as is the usual arrangement. As all railroad men know, the effect of exhausting into the smoke-box is to create a draft on the fire. Since much of the work of the air-brake pump is done when the locomotive is at a standstill, or going down a grade, this means that fuel is consumed needlessly, and for this reason the exhaust pipes were changed. Tests made by the company show that a saving of about 1,000 pounds of coal per locomotive is effected on the descent of the grade from Glen Summit to Penn Haven Junction, Pa., a distance of about twenty-six miles.

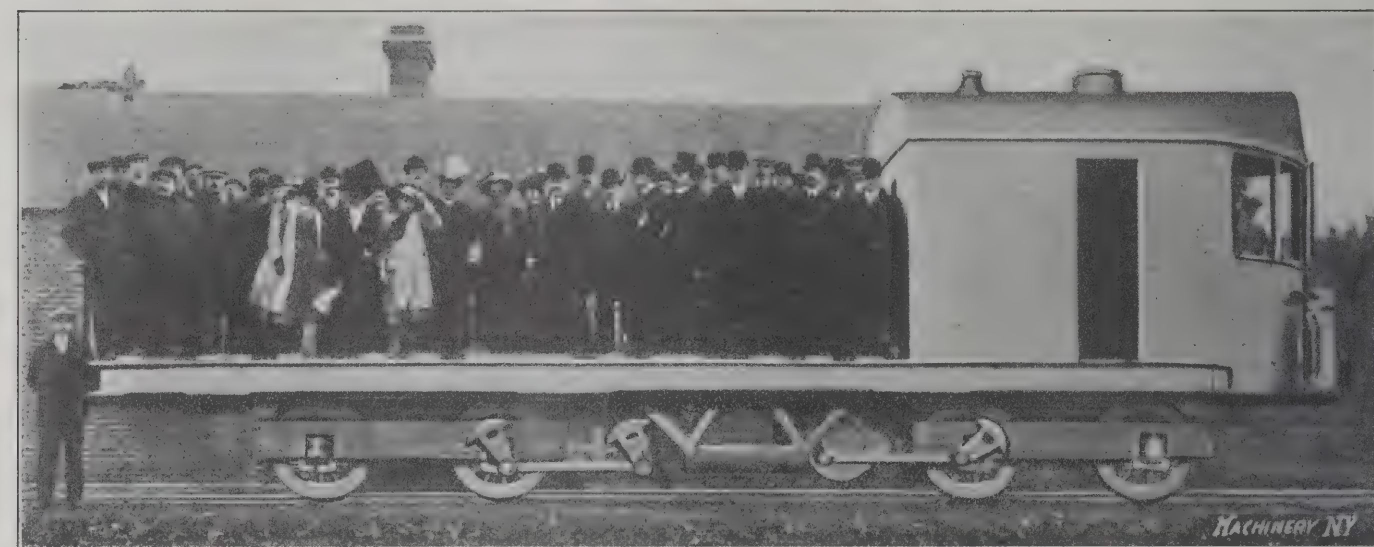
* * *

The Canadian Government has decided to call for bids for the new Quebec bridge to take the place of the one which collapsed during construction August 29, 1907. The span has been reduced from 1800 to 1715 feet. Plans have been completed for both cantilever and suspension type bridges. The style to be adopted will depend upon the cost and time of erection of each, and the general usefulness as compared with expenditure.

NEW BRENNAN MONO-RAIL CAR

Mr. Louis Brennan, who a few years ago invented a monorail car which is capable of maintaining its balance on a single rail, nothwithstanding the fact that the center of gravity is considerably above the rail, has now completed a full-sized car, which during a recent demonstration carried forty persons without mishap. The car is 40 feet in length, 10 feet wide and 13 feet in height to the top of the cab in which the machinery is contained. It weighs, empty, 22 tons and is capable of carrying loads up to 10 tons. Those who read the description of Mr. Brennan's working model that appeared in the August, 1907, number of Railway Machinery, will recall that the car maintains its balance, even when the load is shifted to one side, by the gyrostatic action of two fly-wheels, which are operated in opposite directions by electric motors. The two gyroscopes, which form the balancing mechanism of this latest car are 3 feet, 6 inches in diameter, weigh three-fourths of a ton each and run at the rate of 3,000 revolutions per minute in vacuum. A petrol engine on the car generates the electric power by which these gyroscopes, as well as the driving wheels of the car, are actuated. Each of the two trucks upon which the car is mounted contains two double-flanged wheels which run on a heavy rail having a slightly rounded bearing surface. The demonstration of this new car was successful beyond expectation, and it carried its forty passengers around on a single rail smoothly and without vibration, taking curves and irregularities in the track with perfect safety and absolute stability. There was not the slightest tendency on the part of the car to leave the rail, so perfect was the gyrostatic control. To demonstrate the stability of the apparatus, all of the forty passengers were crowded to one side of the car, and the only result was that the loaded side rose a trifle owing to the gyroscopic action.

Mr. Brennan does not hesitate to declare that the monorail, which the gyroscope principle makes a practical possibility for the first time, will revolutionize the railway systems of the world. A train running on a single rail can attain with ease and safety, he declares, a speed that is impossible for double-rail vehicles. The Indian Office, the War Office and the Kashmir government have assisted and encouraged Mr. Brennan in the development of his invention, and he is now planning cars triple the size of the present one and expects to attain a speed of 150 or more miles an hour. Since the original model was exhibited, Mr. Brennan has considerably developed and improved his invention. The precession of the gyroscopes was accelerated or retarded in the model by frictional means. In the full-size car, a very clever pneumatic device is employed. It is the automatic control of the precession of the gyroscopes that keeps the car in equilibrium. Mr. Brennan is also the inventor of the Brennan torpedo, which is controlled by the British war department.



Brennan Mono-rail Car with Forty Passengers aboard

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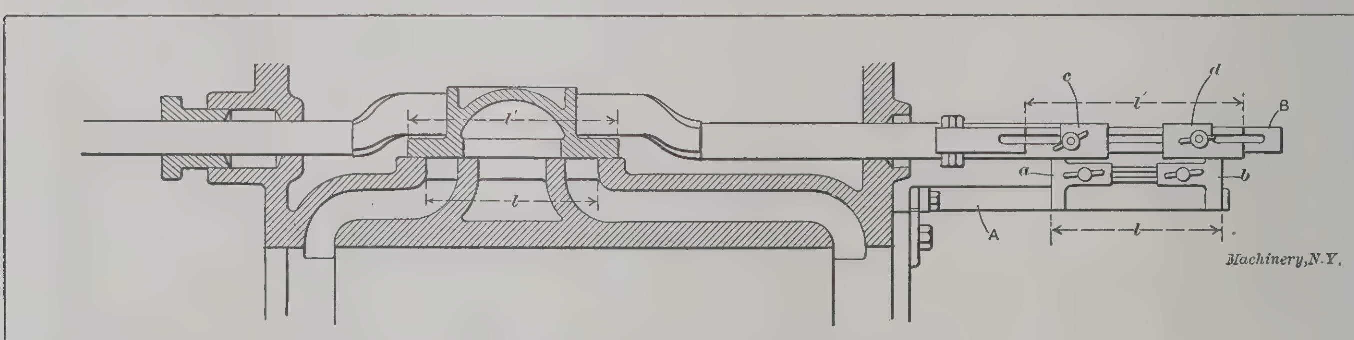
GAGE FOR SETTING SLIDE VALVES

CHARLES R. KING*

There are still a large number of foreign locomotives having slide valves inside of the frames, and it is often difficult to verify the setting of these valves, particularly when they are placed vertically between the cylinders. The following arrangement was devised to remedy this inconvenience, and it is found quite practical in the shops of the French Eastern Railroad.

On the front cylinder cover, or if need be on any part of the locomotive frame, is screwed a bracket *A*, carrying two sliding pieces *a* and *b*, the length *l* between the outside edges of which is adjustable at will. This dimension *l* represents the distance between the outside edges of the admission ports of the cylinder, as shown in the sectional view to the left.



Gage for Setting Valves on Engines with Steam-chests between the Frames

On the extended end of the valve spindle—usual on the European continent—is fixed another piece *B*, also having two sliding parts *c* and *d*, the outside edges of which represent the outside edges of the valve.

The displacements of the valve, relative to the face of the valve chest, are thus indicated outside of the steam-chest, and the valves can be regulated with as much facility as in the case of outside valve chests with extended spindles. The apparatus is arranged for use with different classes of locomotives.

* Address: Staple Hill Park, Staple Hill, near Bristol, England.

FOREIGN ARTICULATED LOCOMOTIVES

A. R. BELL*

For working over the heavy gradients on the Great Southern of Spain Railway, Messrs. Kitson & Co. of Leeds, have supplied three powerful articulated tank engines. One of these is shown in the accompanying illustration, Fig. 1. The cylinders, of which there are four, are 14¾ by 24 inches, all fed with high pressure steam. The valves are of the ordinary flat side pattern and are actuated by Walschaerts gear. The engine is built in three sections. The main frame, 47 feet 4¾ inches long, which carries the boiler, is pivoted at each end on two smaller frames which carry the cylinders, wheels and valve mechanism. The wheel arrangement is 2-8-8-0, the diameter of the small leading wheels being 2 feet 9 inches, while the two sets of eight coupled wheels are 4 feet in diameter. The gage is 5 feet 6 inches. The boiler, which is 5 feet 6 inches in diameter and 15 feet long, carries a steam pressure of 180 pounds per square inch. The tubes, of steel with copper sleeves, are 2 inches in diameter, and 218 in number. The side tanks carry 1,950 gallons of water, and the bunker tank 350 gallons, a total of 2,300 gallons; 2½ tons of coal are carried. The engine is fitted with an automatic vacuum brake, and two double-acting Worthington pumps feed the boiler. The weight of the leading bogie is 107,900 pounds, and the trailing bogie, 94,100 pounds, giving a total of 202,000 pounds, or 101 tons.

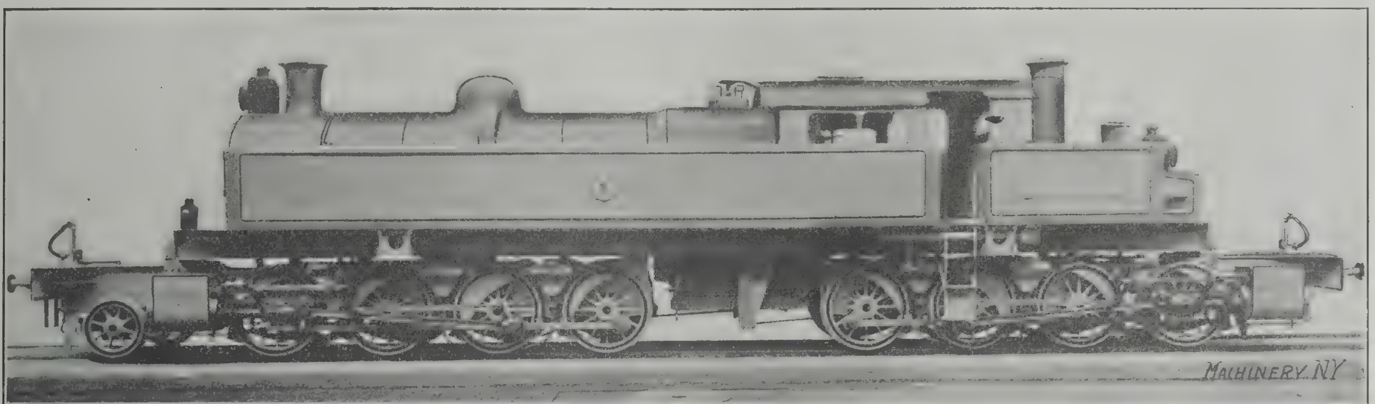


Fig. 1. Articulated Locomotive, Great Southern of Spain Railway

The Antofagasta (Chili) and Bolivia Railway, has added a powerful articulated engine to its stock of locomotives. As can be seen by referring to Fig. 2 it is of the 2-6-6-4 type, the two sets of six coupled wheels being independently driven by two pairs of high-pressure cylinders, 14 inches in diameter by 18 inches stroke, arranged to face each other. The leading and trailing truck wheels are 2 feet 3 inches in diameter, and the coupled wheels are 3 feet 1½ inch in diameter. The wheels grouped in the leading bogie have a wheel base of 12 feet 9 inches, and those in the trailing bogie occupy a length of 16 feet 10½ inches, the total wheel base of the engine being 40 feet 1½ inch, and the length over buffers about 60 feet. The boiler has an outside diameter of 4 feet 4 inches, and carries a working pressure of 180 pounds per square inch. It contains 180 tubes which are 1⅞ inch in diameter, and 12 feet long between the tube plates. The firebox is of the Belpaire type. The heating surface is as follows: Firebox, 104.3 square feet; tubes, 1,054.7 square feet; total, 1,159 square feet; grate area, 25.2 square feet. There are two side tanks carrying 1,225 gallons, and a larger one over the trailing bogie, having a capacity for 2,525 gallons, the total water supply being 3,750 gallons. The bunker holds 4½ tons of coal. The weight of the engine, light, is 120,300 pounds, and in working order, 170,000 pounds—a remarkable figure for a locomotive of 2 feet 6 inches gage. The engine is fitted with the Westinghouse quick-acting brake, and among other specialties are a tank water gage, screw reverse gear, sanding gear, sight-feed oilers, and central buffers.

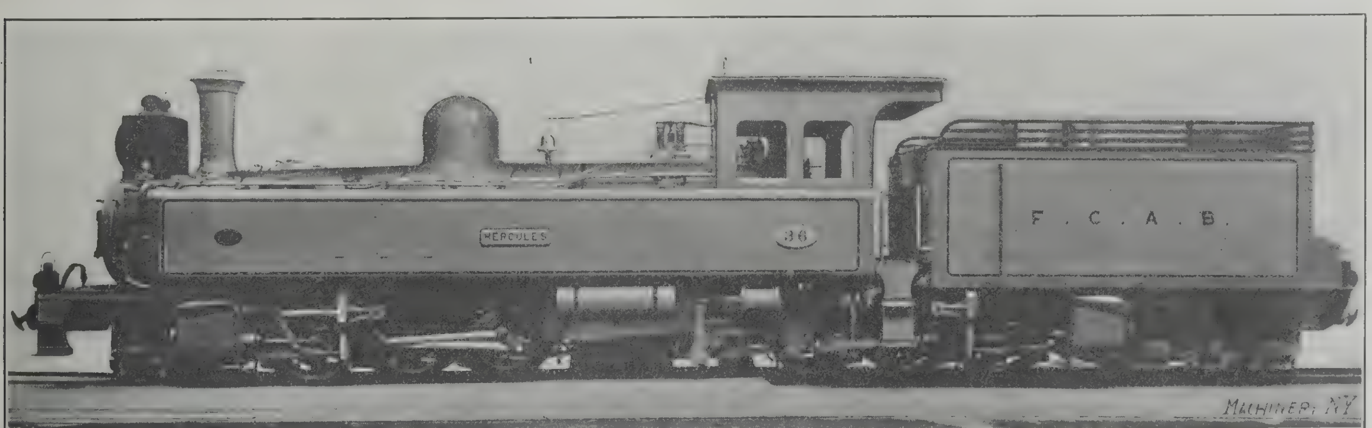


Fig. 2. Articulated Locomotive—Antofagasta and Bolivia Railway, Chili

* Address: Copperkins Grove, Chesham Bois, Bucks, Eng.

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FIRST TRAIN THROUGH PENNSYLVANIA TUBES

The Pennsylvania tunnels under the North and East Rivers were officially inspected on November 18 by President James McCrea and other officers, directors, and minor officials of the road. The first train through the tunnel conveyed the party from Harrison, N. J., to Long Island City, and from there over the new electrified system to Jamaica. As the electrical apparatus has not as yet been installed in the tubes, a locomotive using coke as fuel was used to haul the train. The huge electric locomotives which are to be used when the tubes are completed, are illustrated and described elsewhere in this number. It is estimated that twenty-four of these locomotives will be needed to handle the daily traffic. Mr. C. I. Leifer, the division engineer of the New Jersey division, said that the present intention was to open two of the tubes under the East River by March 1. By July 1 it is expected that the tunnels under the Hudson will also be ready for passenger service. This means that by March 1 it will be possible for Long Island passengers to take a train from the new Pennsylvania station and go direct to any part of Long Island without change. Particular comment was made by the officials on the excellence of the tunnel grades, which are very gradual. Another advantageous feature in connection with the construction of these tubes is the continuous elevated concrete walk which extends throughout their length. This walk enables the track inspectors to inspect the roadbed without danger. At intervals of 50 feet there are stairs descending to the road-

bed, and, in case of accident, it will be possible for passengers to use this elevated walk in getting out of the tunnel. Along the walk at frequent intervals there are seats provided with strong handles to provide against the danger of workmen being drawn to the track by the suction of fast-moving trains.

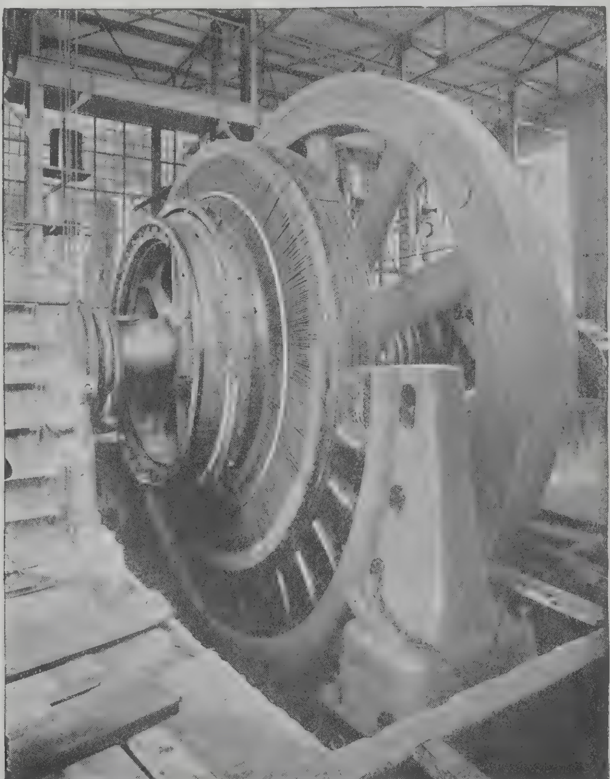
The completion of this tunnel system, the estimated cost of which is approximately $160,000,000, will mark one of the greatest achievements in railway history.

* * *

ACCURATE SHOP WORK ON GENERATOR

The accuracy with which the design and machining of modern machinery is done, is well illustrated by the recent addition to the power plant of the Packard Motor Car Company at Detroit. The addition consists of a 2,000 K.W., 240 volt, 85 R. P. M. Hawthorn generator direct connected to a Cooper horizontal cross-compound engine. Although the generator was completely assembled for the first time in the power house, there was no necessity for cutting or fitting of any sort. Every part and detail fitted together perfectly.

The machine work was interesting on account of the size of the generator, making special work necessary in order to meet shipping conditions. The frame is 22 feet 1 inch in



Direct-current 2000 K.W. Generator during Erection

diameter and weighs approximately 54 tons. When divided into halves and loaded one half to a car, the half frame had a span of 11 feet across the car, or a little more than the railroad's allowance for clearing. Special shipping arrangements overcame this difficulty. The commutator, weighing 15 tons, is 10 feet 4 inches in diameter, but the diameter over the tangs, or leads from the armature, was the determining feature. Since this measurement is 15 feet 6 inches it became necessary to divide the commutator also. It was indeed delicate work to split this annular ring which is built up of 816 copper bars and an equal number of mica insulating segments, and still loosen as few of the segments as possible. This was, however, successfully done. The accompanying illustration, which is a view of the commutator taken during erection, shows it just after being put in place on the shaft. The ring for preliminary tightening is still in place. After the winding was completed, this tightening ring was removed, the commutator heated by short circuiting the windings and all the cap-screws in the end ring were made tight. The commutator was then turned true.

The armature center or spider was shipped in sections, and was bolted and keyed to the engine shaft in the same manner as a flywheel is put in place. The armature core laminations were punched at the factory and packed in boxes. These were stacked after the spider was in place on the shaft. The illustration shows these in place ready to receive the coils of the armature winding.

During the last few days of the installing, when the final adjustments are usually made before putting a generating set into service, this particular installation was rushed to the limit to have it ready in time for a previously announced banquet given in the engine room to the erectors and engineers. A preliminary run of a few minutes was made in the afternoon of October 8. That evening President Joy, of the Packard Motor Car Company, started up the new set before his guests, at the engine room banquet. It was allowed to divide the load with a 1,000 K.W. set for a few minutes, and was then given the full factory load. It carried it without a spark and without any adjustments of any kind having to be made on the set.

Factory work all the way from the designing engineer to the final inspector must be absolutely accurate to make possible the installation and running of such a generating set, made up of a generator weighing 107 tons and an engine having a low-pressure cylinder with a bore of six feet, under full load without adjustments. This generator had been assembled for the first time away from the factory and without fitting or cutting of any parts. This record for installing was made by Mr. H. A. Hoagland, installing engineer of the Western Electric Co., the builders of the generator.

* * *

DEVICE FOR PREVENTING RAILWAY COLLISIONS

An electric automatic safety device, which is the invention of Frederick Lacroix of Texas, for the prevention of railway collisions, was recently tested on the Erie Railroad with satisfactory results. Two trains were started toward each other over a section of track which had been equipped with the necessary electrical apparatus, at a speed of 30 miles per hour. When they were within half a mile of each other the air brakes were set automatically, and with the same gradually increasing force which a skillful engineer would employ in bringing his train to a halt. Both trains stopped, quite far enough from each other to avoid the slightest chance of mishap, yet in neither of the locomotives did the engineer move a hand toward throttle lever or air brake control. Everything was done automatically.

The test was repeated six times, at various speeds and over various distances, and not once did the automatic device fail to work. It was not alone as a safety device, however, that the invention demonstrated its usefulness. By it, telephonic communication was established between the office of Oliver Harriman, at 111 Broadway, and his brother James, who was a passenger on the special, and who listened to the stock quotations read to him from his brother's office while the train sped along at thirty miles an hour. Mr. Lacroix said that the telephonic device would work just as well at a greater speed or at a more extended distance.

The invention is operated by a third rail such as is used on electric railroads. A shoe from the locomotive touches the rail and receives power through it both for the operation of the emergency brake and for the telephone. The principle is similar to that of the block signal system. A length of track is divided into zones, and so long as only one engine is in this zone, a green light shines in the locomotive cab. Whenever two trains enter the same zone, however, this light goes out automatically, and when the trains approach within a given distance of each other, the air brakes on each are set automatically. It is possible to arrange the mechanism so that the brakes will be applied with great speed, or so that they will operate gradually. The ten miles of track between Newark and Nutley were divided into five zones of two miles each when the test was made, and it was asserted by Mr. Lacroix that zones of this length are ample to assure the stoppage of trains, even should each be making sixty miles an hour when the device is called into play. At the close of the test the railroad men who were present declared that the device had fulfilled their greatest expectations.

MODERN LIGHT-TRAIN LOCOMOTIVES

CHARLES R. KING*

In strenuous competition with electric surface railways, the railway companies throughout entire Europe have adopted a service of light runabout trains. Some of these have the locomotive placed between one or two cars, and the engineer in his compartment at either end of the train, where are located suitable levers and rods, controls the engine and brakes, while others have motor cars which are able to haul two or three vehicles, and which are also controllable from either end of the train. Many have found it most practicable to employ small locomotives specially designed for operating, with great economy, light trains running at moderate express speeds, and of all three methods, the last-mentioned appears to be meeting the most favor.

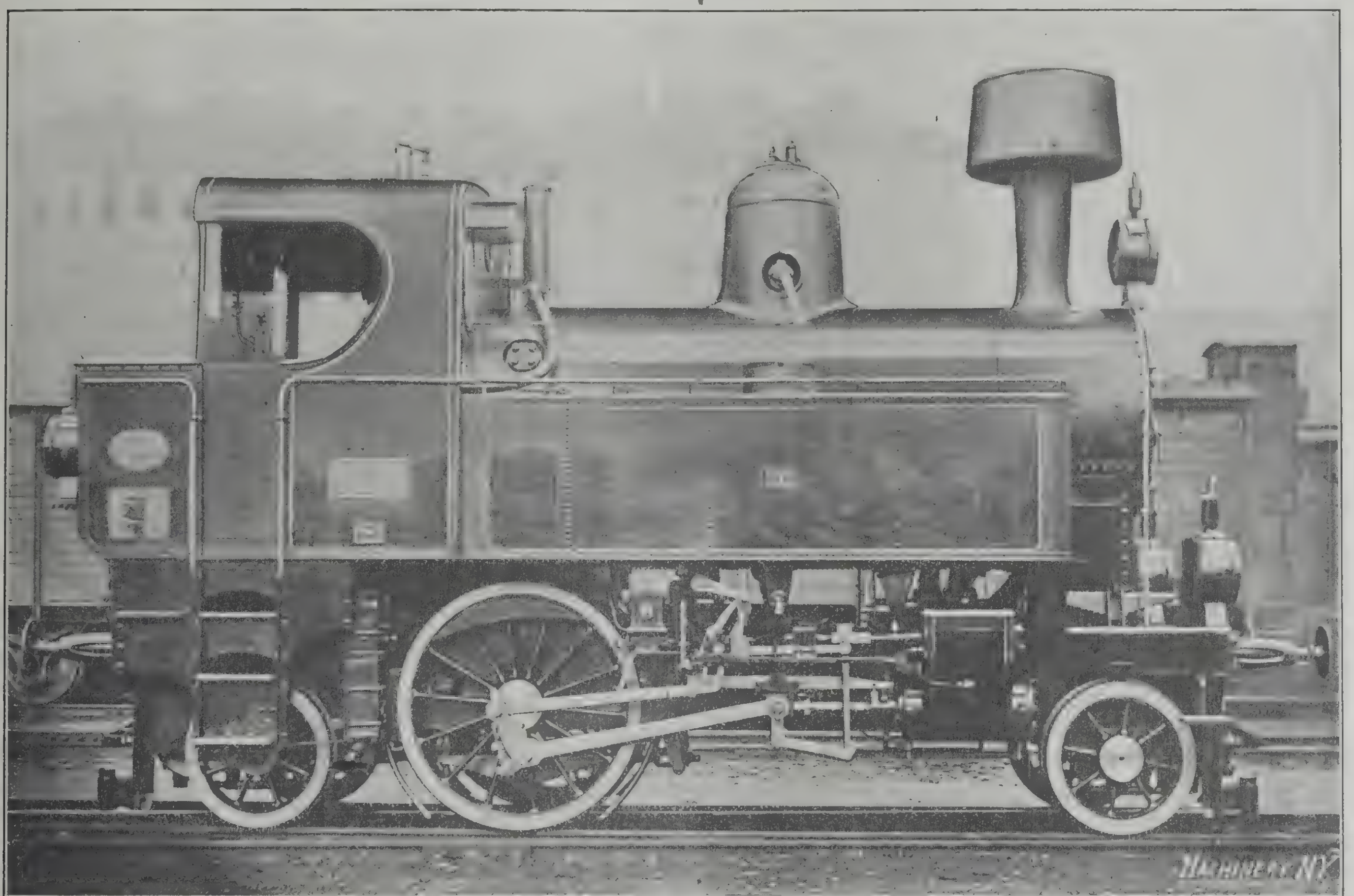


Fig. 1. Superheated Steam, Compound, Light-train Locomotive on the Austrian State Railways

One of the most prolific errors that is current is the supposition that such forms of light traction are new; in reality they have been introduced and reintroduced again and again almost since the creation of railways. The only novelty in these so-called new systems of rail traction is in the mechanism or in some particular disposition of the engine for rendering the traction of light trains especially economical.

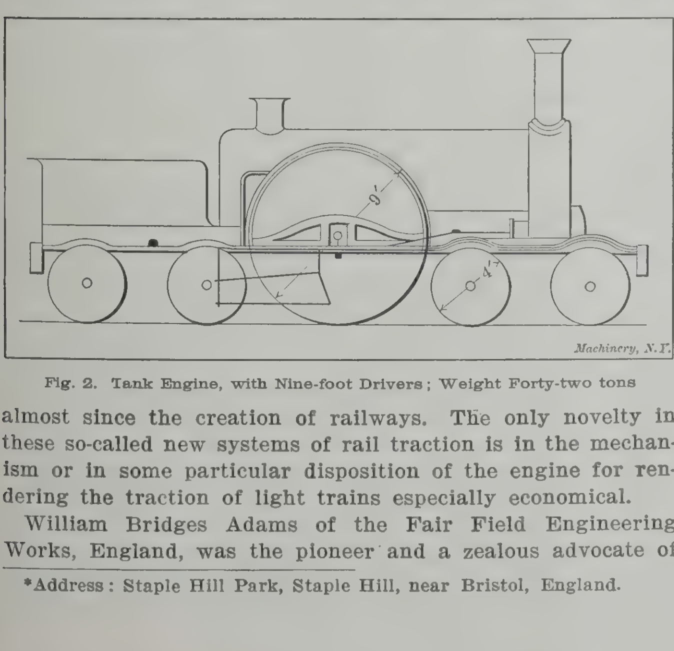


Fig. 2. Tank Engine, with Nine-foot Drivers; Weight Forty-two tons

William Bridges Adams of the Fair Field Engineering Works, England, was the pioneer and a zealous advocate of light-train traction. This noted engineer published a work, entitled "Road Progress," in the year 1850, which gives many figures on the costs of operating light-train locomotives. His arguments for the "light-system" are the same as those employed to-day to justify rail motor coaches. The system of motor coaches was tested on the Exeter to Bristol (England) broad-gage (seven-foot gage) railway in 1850, which was then worked by the broad-gage engines of the 4-2-2 type, and in 1856 by the tank engine, having 9-foot driving wheels, shown in the diagram Fig. 2. The "Fair Field" steam car was constructed for working the Tiverton branch of the Bristol and Exeter Railway. It had six wheels, the two front ones (4 feet 6 inches diameter) being the drivers, which were worked by two cylinders 8 by 12 inches. The other wheels were 3 feet 6 inches diameter. The total heating surface was 362 square feet. Pulling two trail cars, the steam coach made an average speed, on a rising grade of 1 in 86, of 27 miles an hour. This steam car weighed 15.3 tons, and the train 31.7 tons. The whole train ran on 14 wheels as against 14 wheels for the express locomotive and tenders of the Great Western locomotives without any cars. The coke consumption was 14.8 pounds per mile, but subsequently this was reduced to 13 pounds, and still later to 8.7 pounds. The motor coach seated 58 passengers in three compartments; there must have been an average, therefore, of over 9 persons on each seat—the seating capacity of the old G. W. R. broad-gage cars was seven.

The "Fair Field" motor coach ran from Exeter to Bristol, a distance of 76 miles, with a trail load of 10 tons—corresponding to 140 passengers total—at an average rate of 28 miles per hour, the maximum speed being 47 miles per hour, and which was later increased to 52 miles per hour. The coach was then tested on the Clevedon Branch from the Great Western line between Yatton and Clevedon (a point on the Bristol Channel), the speeds averaging from 22 to 26 miles per hour; coke consumption 8.7 pounds per mile, and water evaporated per pound of coke, 7 pounds. The cost of the coke was $5.12 per ton. This steam coach was employed between train times in switching trucks and pulling wagons.

The success on the Great Western line with motor cars, induced the Eastern Counties (now Great Eastern) Railway to order from the Adams Co. the "Enfield" car for 84 passen-

*Address: Staple Hill Park, Staple Hill, near Bristol, England.

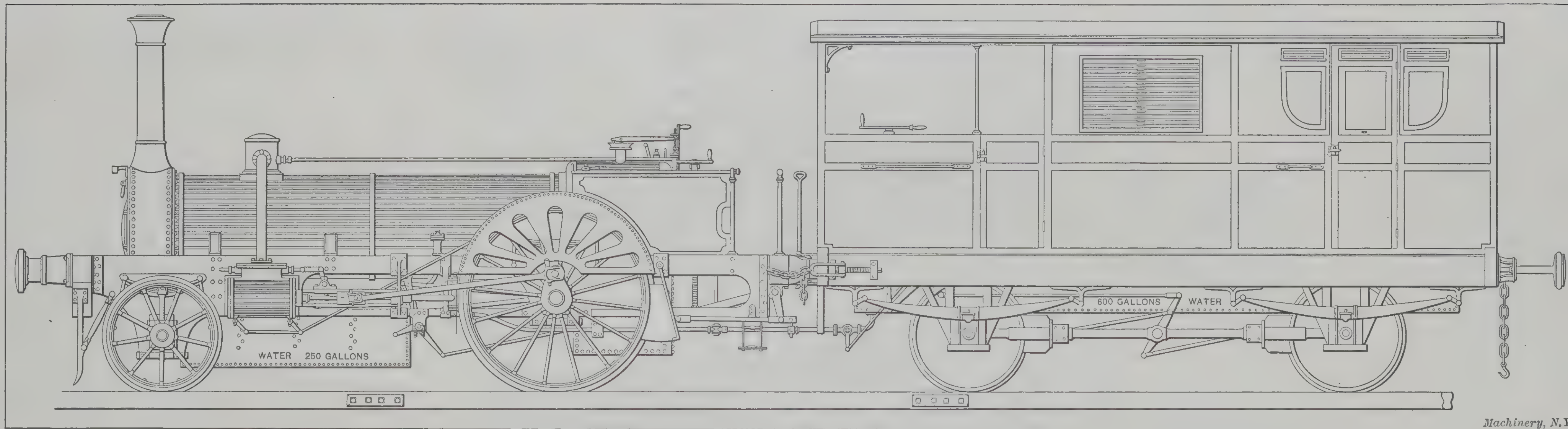


Fig. 3. Type of Light-train Locomotive operated on English Roads prior to 1850. Cylinders, 9 x 15 inches; Driving Wheels, 5 feet; Coke Consumption, about 9 pounds per mile

gers taking two trail cars, or 150 passengers in all, at a regular speed of 34 miles per hour. The Cork and Bandon Railway (Ireland) resorted to the system of running frequent light-running trains, and ordered locomotives of 8½ tons (with 8 by 12-inch cylinders) of a type similar to the one shown in Fig. 3. The very low cost of operation as compared with ordinary engines was then found to be a very attractive feature of the system. The Eastern Counties Railway then ordered the "Cambridge" light engine for 180 passengers for the express service between London and Norwich, a distance of 126 miles. The average rate of speed was to be 30 miles per hour. The foregoing details appear in Mr. Adams' book, together with a drawing (Fig. 3) of his light type of engine as built for a given number of passengers instead of for a specified number of cars. An engine of very similar type is still to be seen at the Crewe Locomotive Works of the London and North Western Railway, rigidly attached to an elegant saloon car which is at present employed for conveying the railway directors of the company, when they visit that extensive works.

From the foregoing it is evident that the light-engine, light-train, system is very old; and Mr. Adams' system received very favorable comment in the money columns of the daily press—notably in the *Times* of December 24, 1849. Since that time, up until the present, the system has been spasmodically revived from time to time in all countries as a means of economy, and then, as the urgency for economy has become less, the system has been quietly abandoned, and all but forgotten. In the United States as well as Europe, the system has also been practiced in days gone by. In the year 1861 the San Francisco, Market Street, Railroad had four very fine steam cars at work. These cars, built by C. W. Stevens, ran on eight wheels with the 2-2-4 arrangement, and were practically identical with that shown in Fig. 2, except that the car body was very long and was carried on the same frame as the engine. The *American Railway Review* in illustrating these fine cars in its issue of January 30, 1862, said: "They will ultimately take the place of heavy locomotives and tenders for such roads."

In Austria, the firm of F. X. Komarek, Vienna, builds a similar type of steam coach, with a single pair of driving wheels for trunk-line service.

Detachable locomotives—*i. e.*, on separate frames—are preferred because during repairs they do not lay up the cars also. Examining the real progress made with such light engines for trunk lines, and comparing the engines of William Bridges Adams built for the Cork and Bandon, Edinburgh & Glasgow, Caledonian & Dumbartonshire, Londonderry & Enniskillen and English Great Eastern railways, previous to 1850, with those designed for main line traffic on the State Railways of Austria, in 1908, the chief improvement is found to be in the adoption of two-stage expansion for superheated steam. Beyond this, the locomotives of chief consulting engineer, Karl Goelsdorf, are substantially the same as those built by the pioneer and advocate of the system, W. B. Adams—that is, a horizontal boiler with two outside cylinders placed behind the front wheels and a pair of larger driving wheels under the firebox. A difference of detail of secondary consequence to be noted, is that Mr. Adams placed part of the water tank under the first trail car, while Mr. Goelsdorf carries the whole of it on the engine frames, so giving rise to the need for a small pair of trailing wheels beneath the cab. The similarity is otherwise striking. Proceeding into details, the light-train engines of 1849-50 appear to have been fitted with the link valve-gear due to Howe in 1843, while the modern Austrian light-train engines are fitted with the now modern valve gear as invented by Florian Angelé in March, 1843, combined with the lead lever of Egide Walschaerts, invented in October, 1844. In the modern locomotive, all that is comparatively new is the reintroduction of superheated steam—a practice initiated by Richard Trevethick in 1828—and the application of the compound system as introduced by Mr. Mallet in 1876, but combined with a device, due to Mr. Goelsdorf, by which the engines are enabled to start with great promptness without the addition of any one moving part which does not exist already in simple engines of the Bridges Adams' type.

The boiler being very short, the smokebox-type of superheater is sufficient for a moderately high superheating effect calculated to add an economy of about 15 per cent to that obtainable by double expansion of the steam. The ratio of the cylinder volumes (only 1 : 2.36) is exceptionally low, which is unusual in consideration of the fact that the steam is only superheated after exhaust from the high-pressure cylinder. Ordinarily it is usual to find the use of small low-pressure cylinders advocated whenever the steam is superheated previous to entering the high-pressure cylinders, because, it is stated, the steam undergoes a loss of volume with its de-

creased temperature in the low-pressure cylinder. In this light-train engine, the application of such reasoning would have entailed cylinder ratios approaching marine practice—considerably over 1 : 3—and as the contrary method has been employed, it would appear that there is no practical reason for increasing the high-pressure cylinder volumes and decreasing the low-pressure volumes when superheating the steam previous to its entry into the large cylinders. With saturated steam the adoption of a ratio lower than 1 : 2.7 for a boiler steam pressure of 175 pounds has usually resulted in complete failure. In Great Britain, ratios of 1 : 1.9 to 1 : 2.08 have been persistently employed, and the total failure of such attempts, instead of being attributed to this cause, have been charged to the unsuitability of the principle employed; and at the present day there is not, in England, one compound locomotive with ratios of cylinder volumes appropriate to the principle of two-stage expansion. The imported du Bousquet locomotives of the French Nord Railway having ratios of 1 : 2.77, are operated in such a manner as to render the system of two-stage expansion nearly useless—so that better results are obtained by single expansion. This is done by means of two valve gears; the high-pressure running cut-off being 30 per cent of the piston stroke with the low pressure set for 60 per cent. As a consequence, the receiver pressure is kept down to 25 pounds per square inch, or one-ninth of the boiler pressure. Instead of the low-pressure cylinders being made to perform their moiety of the work, by means of co-equal cut-offs of 40 per cent in both cylinders, resulting in 75 pounds receiver pressure, the high-pressure cylinders are made to contribute from 70 to 75 per cent of the total power output. In this way the British engineers have found the compound principle worse than useless; and not knowing or caring how to apply the system to better advantage, they are now twenty years behind American and Central European practice, where ratios of nearly 1 : 3 are the standard.

A superheated steam, compound, locomotive that serves the Austrian main line intermediate stations, with a trail load of three to four cars of 40 to 50 tons' weight, at all speeds up to 50 miles per hour is shown in Fig. 1. With a train of four cars from Vienna to St. Roelten, a distance of 61 kilometers, it maintained a speed of 62 kilometers (38.4 miles) per hour on a long grade of 1 per cent, on the Rekawinkel incline, and attained 103 kilometers (63.8 miles) per hour on the level. The water consumption for the whole run of 61 kilometers was 1,600 liters (425 gallons). The fuel used is lignite coal.

This engine was built by the noted firm of Krauss of Linz, in Austria, and Muenchen in Bavaria; and being designed especially for a given service, only varying within narrow limits, it is found to answer satisfactorily the new exactions for rapid and frequent trains at a minimum cost for operation and maintenance.

Principal Dimensions of Austrian Light-train Locomotive

Cylinders, high-pressure, 260 millimeters; low-pressure, 400 millimeters.

Piston stroke, 550 millimeters.

Driving wheels, diameter, 1,450 millimeters.

Boiler, diameter, 1,200 millimeters; tubes, number, 130; out side diameter, 46 millimeters.

Superheater pipes, number, 16; outside diameter, 33 millimeters.

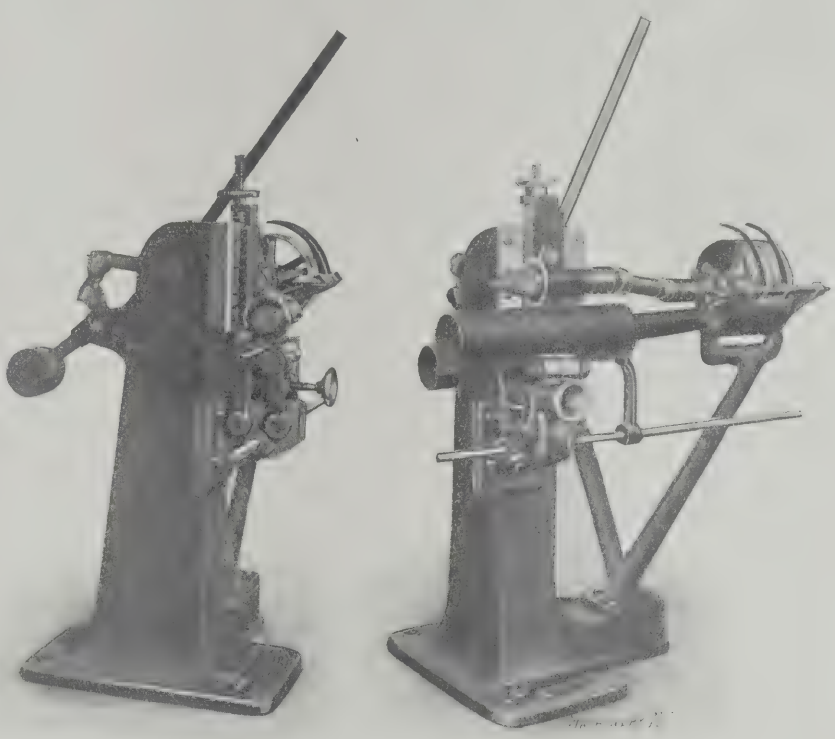
Grate area, 1.027 square meter.

Heating surfaces: fire-box, 5.2 square meters; flues, 46.96 square meters; superheater pipes, 3.29 square meters; steam pressure, 15 atmospheres.

Weight of engine: empty, 24.1 metric tons; load on leading axle, 10 tons; on driving axle, 14.3 tons; on trailing axle, 7.3 tons; total, 31.6 tons.

RYERSON FLUE-CUTTING MACHINE

An interesting design of flue-cutting machine, which has recently been placed on the market by Joseph T. Ryerson & Son, Chicago, Ill., is shown in the accompanying illustrations. This machine, which is the result of considerable experimenting along this line, is adapted to a general range of work and is so designed as to occupy a small amount of floor space. The machine is practically noiseless in operation, and it has a capacity for cutting tubes or pipes ranging from ⅜ inch to 6 inches in diameter. It is so arranged that the work may be cut off to any desired length, and the operation is very rapid. The cutter-wheel is directly connected by universal joints to the driving-shaft. The tight and loose pulleys on this shaft are 12 inches in diameter, and should run at about 200 revolutions per minute. The slide on which the cutter is mounted is adjusted vertically for different diameters of tubing by the hand-wheel shown at the top of the machine. The object of this offset drive through the universal joints, is to provide clearance for the tubes or pipes back of the machine so that they may be adjusted to any position and cut to any desired length. The feed of the cutter is accomplished by means of the hand-lever shown. This lever is equipped with a balance-weight, as shown, that provides an automatic release. Very little pull is required on this lever to cut tubes of any size. The rollers on which the tube revolves while it is being severed, are arranged so that they can be quickly brought close together or spread apart to the proper distance for work of various diameters. This adjustment is made by the small hand-wheel and screw shown. For reaming out the slight burr from the inside of the tube, which is sometimes caused by the cutter-wheel, a fluted conical reamer is provided that is attached to the end of the cutter-shaft. This reamer will ream tubes up to and including 3 inches in diameter. If desired a larger reamer for tubes of greater diameter can be furnished. This larger reamer, when furnished, is attached to the opposite end of the shaft just outside of the end bearing box. Each machine is equipped complete with one cutter-wheel 4½ inches in diameter, a fluted reamer suitable for tubes up to 3 inches in diameter, and all the necessary wrenches. The makers state that this type of flue-cutting machine is in use in a number of the leading shops and is giving entire satisfaction. The approximate weight of the machine is 325 pounds. The makers will be glad to furnish additional and more detailed information if it is desired.



Two Views of the Ryerson Flue-cutting Machine, showing it set up for Work of Large and Small Diameters

CLAMPING DEVICES*

LUCIEN L. HAAS†

If the reader will carefully go over the twenty illustrations of different clamping devices found in the accompanying Data Sheet, he will find that some of them are very similar; yet the mechanic will be able to cite many instances where one, and only one, of these types can be used to advantage. Of course, it will be understood that these illustrations are diagrammatical and are intended to indicate the principles of various clamping methods rather than the actual design and construction of the clamp itself. In order to make each illustration more complete, the work itself has been represented in each case by sections shown in solid black.

Figs. 1 and 2 represent the every-day method of clamping work to the table of a milling machine or to the face-plate of a lathe. The type of clamp shown in Fig. 3 is commonly used for holding work in a drill jig when one bolt or screw is sufficient, especially when it is desired to have an open end jig. Fig. 4 illustrates a scheme which is not often found in use. This type of clamp is adapted to box jigs; it has the advantage of being easily removed, which is accomplished by sliding it longitudinally. By glancing at the detailed view to the right, which shows the end of the clamping bar and its retaining grooves, the way in which it is held in place and removed will be clearly understood. Figs. 5 and 6 show clamps which are very much alike, but as a great many mechanics use the design shown in Fig. 5, I added that of Fig. 6, as it is both simpler and two-to-one quicker, when it comes to removal. It will be noted that when the clamp is slotted as shown in the plan view of Fig. 6, fixed studs may be used instead of the swinging bolts. As there are a great many mechanics who prefer the cam as a means of clamping, the illustration Fig. 7 is presented as a reminder of the application of this principle. As is well known a cam can be used in possibly a hundred different ways. The type shown in Fig. 8 is often found in machine shops, on milling fixtures, drill jigs, lathe fixtures, etc. The clamp and bolts can be removed by loosening the nuts and pulling out the slip washers which allow the nuts to pass through the large holes. Fig. 9 illustrates a scheme which is commonly used on milling fixtures when light milling is to be done. The design of clamp shown in Fig. 10 is not frequently seen in use as it is a scheme which a mechanic will not use if he can see another way out of it; but at times it is found almost impossible to use a clamp of any other type. Fig. 11 shows the style of clamp that is used in connection with box drill jigs when it is desired to support a part to be drilled on two points. As will be seen, these two bearing points are self-adjusting. The design of Fig. 12 is generally used when it is desired to support the work in two places in an open-end drill jig. Figs. 13 and 14 show types which are quite similar, but, as before stated, there are many cases where one type can be used to advantage and not the other. For instance, the clamp, Fig. 13, is intended for box jigs and one would not think of using the type of Fig. 14 in such a jig, because the latter is altogether too slow. However, its advantages over Fig. 13, in case it is desired to have an open end jig, are apparent. The relation of the first cost of a jig to the quantity of work to be done, is a factor which sometimes makes a jig which is not perfect from a purely mechanical standpoint, more desirable than one which represents better design but greatly increased cost. Fig. 15 shows the old hook-bolt scheme, a clamp which is found in use almost as often as that of Fig. 1. The type shown in Fig. 16 answers practically the same purpose as that of Fig. 11, and it is used on, I dare say, one-third of the drill jigs now in use. A style of clamp that is somewhat similar to the one illustrated in Fig. 4, is shown in Fig. 17. In this case, however, two clamping bolts are used and the clamp is removed from the end of the jig. This is a good, as well as a quick method, of clamping work in open-end drill jigs. Fig. 18 illustrates the use of bolts only, for holding down work. The illustration is self-explanatory. Fig. 19 shows a good design of clamp for holding work in a milling fixture. It binds the work both horizontally and vertically and "has it all over" any other type when it can be used. The last but not the least of the clamping devices is shown in Fig. 20, which illustrates the wedge method. This is found in use in about every machine shop in the world, and its application is familiar to all mechanics.

* With Data Sheet Supplement.

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* * *

TURBINE LOCOMOTIVE FOR RAILWAYS

President Hugh Reid of the Glasgow University Engineering Society has announced that a new locomotive is under construction which may lead to the application of steam turbines to locomotives. Mr. Reid describes this engine as the first steam turbine electric locomotive. Various proposals had been made to electrify the existing steam railways, he said, but the anticipated cost of conversion and of prospective and subsequent maintenance had hitherto prevented progress. Attempts had also been made to introduce independent self-generating electric units that might operate over the existing railway systems without necessitating any electrical equipment on the railways themselves. The Heilmann steam-electric locomotive which was built in 1894 was an example of a unit of this type, but Mr. Reid asserts that the new steam turbine electric locomotive which is now being built by the North British Locomotive Company is a much more practical development.

The steam is generated in a boiler of the ordinary locomotive type, which is fitted with a superheater. The steam from the boiler is led to a turbine of the impulse type, running at a speed of 3,000 revolutions a minute, to which is directly coupled a continuous current, variable voltage dynamo or generator. The dynamo supplies electrical energy of from 200 to 600 volts to four series of wound traction motors, the armatures of which are built on the four main or driving axles of the locomotive.

The exhaust steam from the turbine passes into an ejector-condenser, and is, together with the circulating and condensing water, delivered eventually to the hot well. As the steam turbine, unlike the reciprocating steam engine, requires no internal lubrication, the water of the condensation is free from oil and consequently is returned from the hot well direct to the boiler by means of a feed pump. The water evaporated by the boiler is therefore returned to the boiler again and again, and the supply of water carried in the tanks is actually circulating water for condensation purposes. This condensing water is circulated within what is practically a closed cycle, by means of small centrifugal pumps driven by auxiliary steam turbines placed alongside the main turbine and dynamo.

Mr. Reid declares that the idea is the outcome of much thought and experiment extending over a period of several years, and it is being carried out on a large scale. As the engine under construction is intended for express passenger work, Mr. Reid hopes to obtain comparisons from its actual working with the performances of reciprocating steam locomotives, especially as regards the relative consumption of fuel and water, and also as to the efficiency of transforming the energy of steam into draw-bar or train pull, and also relative to the rapidity of acceleration under the old and new systems.

Most of the component parts of this steam turbine electric locomotive have already proved themselves effective and efficient in other applications, and the novelty lies in the combination of the different elements of which the locomotive is composed. The expected results in this case should not therefore, Mr. Reid believes, be so problematical as in the case of an invention where the novelty is in the details. It is the question of the cost of the locomotive which most troubles the patentees or raises any doubt as to its general adoption.

* * *

The Canadian Pacific Railroad has found telephone train despatching so satisfactory on a system of 500 miles that it will extend the system operated by telephone despatching to 1,000 miles within a year. It has been stated that 50 per cent more traffic can be handled than was possible with the telegraph system of despatching. This, of course, may not be due entirely to the new system of despatching, but to other improvements as well.

ELECTRIC DRIVE OF TURBINE PUMPS*

It is becoming a well-recognized fact that the electrical engineer, in order to successfully solve the problems of his particular science, must give earnest study and work to many other branches of engineering. The peculiarities of electrical rotating machinery make it desirable, and often essential, to obtain a thorough knowledge of the mode of operation, variation of load, and nature of product, of the mechanical apparatus that it will be applied to. The point of view of the electrical engineer is in this study so different from that of the mechanical engineer in designing his part of the combination that it should cause no surprise if the investigations of the former must run along entirely original lines. Such has most prominently been the case in introducing the electric motor in steel, cotton and paper mills, or when applying gas engines to the driving of electric generators. The turbine pump, to which this paper will be devoted,

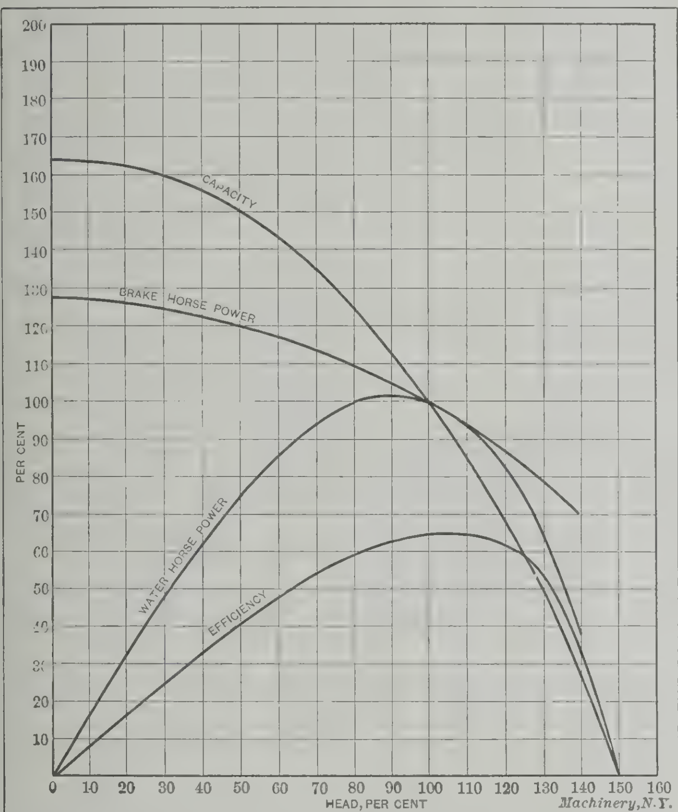


Diagram showing the Relation between Capacity, Brake Horse-power, Water Horse-power, and Efficiency of Centrifugal Pumps running at Constant Speed

has been comparatively neglected, and yet the erratic conditions found in many pump installations show the unquestionable necessity for a better understanding of the problem involved in electric drive of turbine pumps.

The troubles experienced indicate that there are two principal questions, the correct solution of which insure successful electrical operation of turbine pumps. First, the selection of the proper size of motor to take care of varying load conditions; second, the selection of the proper type of motor to meet different starting requirements.

Taking these questions in the order just mentioned, it first becomes necessary to investigate how the load on a turbine pump running at constant speed or nearly so, varies with varying capacity and head. The variation of the load with different speeds is less important and less involved. It is less important, because at each speed that may be desired our reasoning for constant speed is applicable. It is less involved, because the behavior of the turbine pump in this respect is well known, and all necessary information is voluntarily and fairly accurately supplied by the pump manufacturer. The self-evident necessity of allowing margin in the motor for different speeds has caused this condition to be well taken care of. The most frequent speed variation desired is one speed for so-called domestic service pressure and another for fire service pressure. In the case of multipolar alternating current motors, this variation is generally accomplished by using a different number of poles for the two speeds.

At each constant speed, however, it will be found that most pump manufacturers are by no means certain as to how the load on any particular pump varies with varying head. Neither do they seem to think accurate information in this respect of special value. A glance at the accompanying diagram, which shows a typical relation between head, capacity, efficiency and brake horse-power in ordinary commercial turbine pumps demonstrates the great importance to the electrical engineer of obtaining a similar diagram or equivalent information wherever he undertakes to prescribe the size of the motor. In this diagram an efficiency of 65 per cent is assumed, but the relations given will be approximately correct for all efficiencies between 50 and 80 per cent.

The pump ought to be adapted for an average head corresponding to its maximum efficiency. This head, however, will nearly always vary considerably; the water level will, for instance, rise and fall in the source of supply and in the tank or reservoir into which the water is pumped, or if the water is forced directly into a distribution system, the varying demand will frequently cause the discharge pressure to vary over a wide range. The emptying of dry-docks through turbine pumps presents a particularly interesting problem of this nature. In such cases it will be found that when the *head falls off*, the capacity generally increases, and as the efficiency at the same time goes down rapidly, *the load* in most turbine pumps *increases.* It becomes imperative, therefore, that the electrical engineer should know what this overload amounts to, within the range of abnormally low head liable to occur, and the duration of such overloads.

It is true that the pump manufacturers are beginning to realize that this characteristic of the turbine pump makes it unsuitable for electric motor drive, and that they, therefore, have endeavored, and partially succeeded, in "flattening" the capacity curve over a considerable range, thereby making the horse-power required fairly constant between the same limits; but the electrical engineer will as yet seldom meet this condition, and in any case it is safe to remember that the size of the motor is governed by capacity at low rather than at high head. Where no information in this respect is obtainable, it is safe to assume the relations shown in the diagram. On account of the efficiency in all motors, and the power factor in induction motors, being lower at lighter loads, electrical engineers should use every opportunity to impress upon pump builders the desirability of designing pumps with a horse-power curve as flat as possible.

Official test records of pumps recently furnished the U. S. Government for dry-dock purposes will soon be published, and will show that the desired constancy in load has been reached almost to perfection. In these pumps the vanes of the impellers act themselves as automatic throttles, so to speak, restricting the capacity with decreasing head so that the energy consumed is kept constant.

It is often left to the electrical engineer to determine the horse-power required by a certain pump from the capacity in gallons per minute, total head in feet or pounds pressure per square inch, and the efficiency of the pump. Frequently, however, the head given in the specifications does not include friction in the water pipes. It is necessary, of course, to make allowance for this factor when calculating the horse-power of the motor. For the convenience of the electrical engineer who meets this problem, the accompanying table is here given, showing the friction head in feet per hundred feet commercial pipe sizes and for different capacities. The number of U. S. gallons delivered per minute multiplied by 8.3 gives the pounds of water handled per minute. This product multiplied by the sum of the total vertical head and total friction head taken from the table gives foot-pounds work done per minute. If the head is stated as composed of suction lift and pounds of pressure delivered by the pump, it is only necessary to remember that each pound corresponds to 2.3 feet static head. As one horse-power is equivalent to raising 33,000 pounds one foot in one minute against the force of gravity, we obtain the work done in the pump expressed in horse-power by dividing the foot-pounds just calculated by 33,000. This

* Abstract of a paper by Mr. J. E. Fries, read before the American Society of Swedish Engineers, at Brooklyn, N. Y., October 16, 1909.

result is often called "water horse-power." A final division by the efficiency of the pump gives effective horse-power required from the motor. The suction lift and the friction head in the suction pipe added together must, of course, be kept as far below the theoretical limit of 32 feet as possible.

The second consideration that must be given serious thought when attempting electric drive of turbine pumps is that of starting. The direct-current motors possess such remarkable qualities in this respect that little difficulties are to be anticipated in their application to turbine pumps, provided they have the proper capacity to handle the load under all other conditions. The great majority of electrically-driven centrifugal pumps are, however, supplied with alternating current. An induction motor of sufficient capacity to handle the expected load will also start the pump successfully, provided the current rush is tolerated. A synchronous motor, on the other hand, may or may not start the pump, the torque of the motor, especially with certain designs, being very small until synchronism is reached, while the torque required by the pump grows with the square of the velocity. Just before the water boiling hot. The only way to partially relieve the load from a primed pump is to close a valve in the discharge pipe and open an outlet between this valve and the pump, thus discharging close to the pump and letting the water go to waste during the period of starting. In the case of a single-stage pump, however, the capacity is much greater at the lower head, and the load may even be more than normal, as pointed out before, but with multi-stage pumps the water passages through the pump do not allow such great increase of water flow as would correspond to the extremely low head, and although it might be thought that the excess energy would be converted into heat, practice shows that the load on the motor is in this way partly relieved.

It is evident from the foregoing that the synchronous motor of ordinary design when applied to turbine pumps may fail to pull into synchronism. As the starting torque in a synchronous motor is due to eddy currents and hysteresis, and more to the former than to the latter, it follows that every means to increase the eddy currents improve the possibility of starting a turbine pump. Thus solid steel poles are far superior to laminated ones. Some manufacturers provide copper rings around the pole tips for the same purpose. A radical, although expensive, method of improving the laminated pole motor, is to provide it with a squirrel-cage winding in the pole faces, thus approximating induction motor starting characteristics. Owing to the big air gap and consequent leakage and also to the uneven distribution of this secondary winding, the torque is far from that of an induction motor.

FRICTION OF WATER IN PIPES

Friction loss in feet static head, for each 100 feet of length in different sizes of clean iron pipes discharging given quantities of water per minute

Gals. per Min.	Size of Pipe, Inside Diameter, in Inches														
	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16	18
5	7.6	1.94	0.72	0.28	......	......	......	......	......	......	......	......	......	......	......
10	30.0	7.3	2.42	1.09	0.28	......	......	......	......	......	......	......	......	......	......
15	66.3	16.1	5.5	2.24	0.44	......	......	......	......	......	......	......	......	......	......
20	116.0	28.4	9.4	3.8	0.97	......	......	......	......	......	......	......	......	......	......
25	180.0	44.0	28.6	6.1	1.48	0.49	0.23	......	......	......	......	......	......	......	......
30	......	63.5	37.2	8.7	2.1	0.69	0.32	......	......	......	......	......	......	......	......
35	......	85.5	46.7	11.7	2.9	0.78	0.35	......	......	......	......	......	......	......	......
40	......	111.0	57.5	15.1	3.7	1.21	0.53	......	......	......	......	......	......	......	......
45	......	......	130.0	18.8	4.6	1.52	0.66	......	......	......	......	......	......	......	......
50	......	......	......	23.1	5.6	1.87	0.81	0.21	......	......	......	......	......	......	......
75	......	......	......	51.8	12.3	4.15	1.71	0.37	......	......	......	......	......	......	......
100	......	......	......	90.0	21.9	7.4	3.03	0.76	0.12	......	......	......	......	......	......
125	......	......	......	......	34.5	11.3	4.6	1.14	0.17	......	......	......	......	......	......
150	......	......	......	......	49.0	16.2	6.6	1.60	0.23	......	......	......	......	......	......
175	......	......	......	......	65.0	21.9	8.9	2.16	0.30	......	......	......	......	......	......
200	......	......	......	......	86.7	28.8	11.6	2.82	0.39	......	......	......	......	......	......
250	......	......	......	......	......	45.4	17.9	4.37	0.60	0.16	0.07	0.02	......	......	......
300	......	......	......	......	......	64.8	25.9	6.37	0.86	0.21	0.09	0.03	......	......	......
350	......	......	......	......	......	......	35.2	8.43	1.15	0.28	0.12	0.05	......	......	......
400	......	......	......	......	......	......	45.0	11.0	1.50	0.37	0.14	0.06	......	......	......
450	......	......	......	......	......	......	57.8	13.9	1.87	0.46	0.16	0.07	......	......	......
500	......	......	......	......	......	......	71.2	17.2	2.22	0.58	0.25	0.09	0.039	0.021	0.012
750	......	......	......	......	......	......	......	......	5.10	1.23	0.42	0.19	0.068	0.039	0.035
1000	......	......	......	......	......	......	......	......	8.95	2.17	0.74	0.30	0.14	0.083	0.093
1250	......	......	......	......	......	......	......	......	......	3.37	1.13	0.46	0.22	0.12	0.11
1500	......	......	......	......	......	......	......	......	......	4.83	1.62	0.67	0.31	0.16	0.13
1750	......	......	......	......	......	......	......	......	......	......	2.20	0.88	0.41	0.21	0.14
2000	......	......	......	......	......	......	......	......	......	......	2.84	1.13	0.54	0.28	0.16
2250	......	......	......	......	......	......	......	......	......	......	......	1.45	0.68	0.36	0.20
2500	......	......	......	......	......	......	......	......	......	......	......	1.78	0.84	0.44	0.25
3000	......	......	......	......	......	......	......	......	......	......	......	2.56	1.19	0.62	0.35
3500	......	......	......	......	......	......	......	......	......	......	......	......	1.61	0.85	0.47
4000	......	......	......	......	......	......	......	......	......	......	......	......	2.10	1.09	0.61
4500	......	......	......	......	......	......	......	......	......	......	......	......	......	1.27	0.77
5000	......	......	......	......	......	......	......	......	......	......	......	......	......	1.69	0.95

synchronism, therefore, is the critical point in starting turbine pumps. The best remedy for this trouble, as well as for excessive starting currents, is to start the pump empty and prime it after full speed has been reached. Where water is not delivered to the pump under pressure, this may be accomplished either by an auxiliary pump of the rotary type, or an ejector where steam is available, in both cases forcing the supply of water up the suction pipe into the pump.

The electrical engineer is often told that although the pump is filled with water, it will start under very light load, because a check valve will be closed either in the suction or in the discharge pipe, and the writer has seen similar statements in specifications issued by consulting engineers of very good standing. The truth is, however, that neither of these expedients improve starting conditions at all. With the valve closed in the suction line, the pump supports the ordinary water column just the same, and with the valve closed in the discharge line, the pump creates a pressure behind the valve, so that in either case the load is practically normal, and the energy consumed is transformed into heat, which soon makes

It seems that where synchronous motors are desired the best solution is to prime after starting. It would also seem, however, that where high starting currents are not objectionable, sufficient starting torque may be obtained in synchronous motors with inherent low starting torque, without the highly expensive squirrel-cage winding, by supplying a starting compensator capable of producing about 25 per cent excess voltage. As the torque increases with the square of the voltage, this means should in most cases prove sufficient. Precautions must be taken, however, to make the change from one voltage to another gradual and not sudden, so as not to overstrain the windings.

METHODS AND TOOLS USED IN METAL SPINNING

C. TUELLS

Metal spinning, that process of sheet metal goods manufacturing which deals with the forming of sheet metal into circular shapes of great variety by means of the lathe, forms and hand-tools, is full of kinks and schemes peculiar to itself. It is the purpose of this article to give a description of spinning in general, and to outline some of the methods and tools used in spinning for rapid production.

The products of metal spinning are used in a great many lines of manufacture. Examples of this work are chandelier parts, cooking utensils, silver and brittania hollow-ware, automobile lamps, cane-heads and many other sheet metal specialties. Brass, copper, zinc, aluminum, iron, soft steel, and, in fact nearly all metals yield readily to the spinner's skill. At best spinning is physically hard work, and the softer the stock, the easier and quicker the spinner can transform it into the required product.

There are but two practical ways of forming pieces of sheet metal into hollow circular articles: by dies and by spinning. By far the cheapest and best method of producing quantities of this class of work is by the use of dies, but there are many cases where it is impractical or impossible to follow this course. Dies are expensive and there is constant danger of breakage, whereas spinning forms are easily and cheaply made and are almost never damaged by use beyond a reasonable amount of wear. Thus it will be seen that when the production is small, it does not pay to make costly dies. Again, the styles or designs of many articles that are spun are constantly being changed; if made by dies each change would necessitate a new die, while in spinning merely a new wooden form is required—and sometimes the old form can be altered, costing practically nothing. Still other advantages of spinning are that in working soft steel, a much cheaper grade may be spun than can be drawn with dies; beads may be rolled at the edges of shells at little expense; experimental pieces may be made quickly, and, added to these features, comes the fact that very difficult work that cannot possibly be made with dies can be spun with comparative ease. It must not be construed from the above that spinning is to be preferred to die work in all or even in the majority of cases, because, on the contrary, die work is a more economical method of manufacture, and should always be used when possible on production work. The cases already cited are merely given to point out some of the instances in which, for economical reasons, spinning is to be preferred to die work.

The Spinning Lathe

The principal tool used in the operation of spinning is the spinning lathe, shown in Fig. 2. While in many respects this machine is similar to any other lathe, it is built without back-gears, carriage or lead-screw, is very rigid in construction, and, on the whole, very much resembles a speed lathe. Like other lathes, the spinning lathe is fitted with a cone pulley (preferably of wood, because of its lightness and gripping qualities), allowing the use of four or five different speeds. Speed is an important factor in spinning. Arbitrary rules for spinning speeds cannot be given, as the thicker the stock the slower must be the speed; thus while 1/32-inch iron can be readily spun at 600 revolutions, 1/16-inch iron would necessitate reducing the speed to 400 revolutions per minute. Zinc spins best at from 1,000 to 1,400 revolutions; copper works well at 800 to 1,000; brass and aluminum require practically the same speed, from 800 to 1,200; while the comparatively slow speed of 300 to 600 revolutions is effective on iron and soft steel. Brittania and silver spin best at speeds from 800 to 1,000 revolutions.

One of the essential parts of the spinning lathe is the T-rest. The base of this rest is movable on the ways of the lathe, and it has at the side nearest the operator, a stud about four inches in diameter and six inches high, through which is swiveled the T-rest proper. As the illustration shows, provision is made for raising and lowering the rest, and the entire rest may be clamped in any desired position by means of the hand-wheel shown beneath the ways. The rest proper consists of an arm, 12 to 15 inches long, similar to a wood turner's rest, and through the face of this arm are from twelve to sixteen closely spaced ⅜-inch holes. These holes are to receive the pin against which the hand tools are held while spinning. The pin is three inches long and of ¾-inch steel, turned down on one end to loosely fit the holes in the rest.

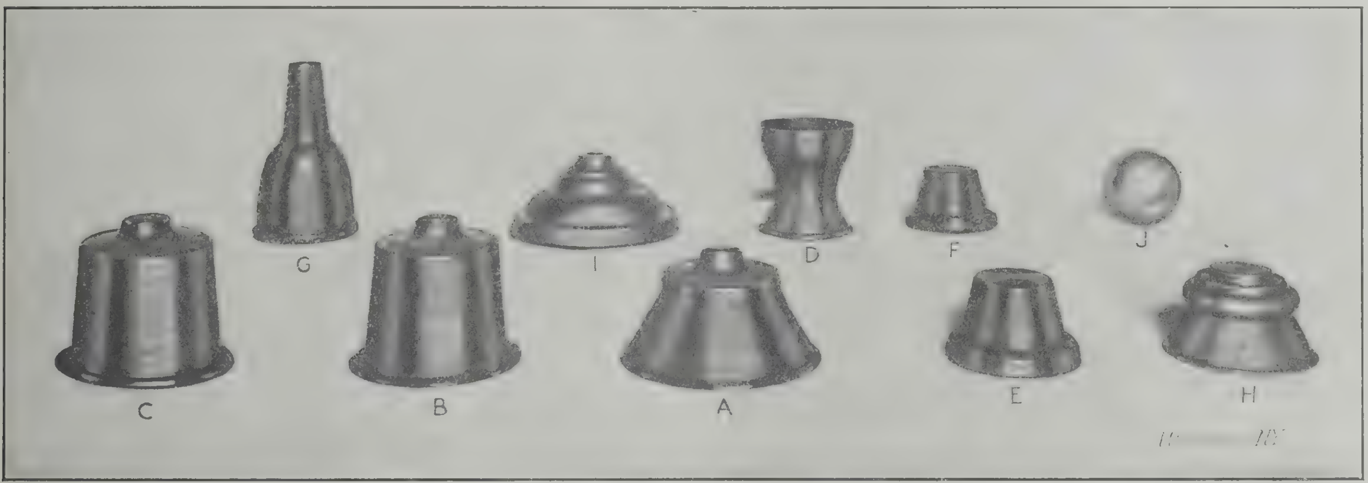


Fig. 1. Specimens of Metal Spinning

Another important part of the spinning lathe is the tail-center. This center is sometimes the ordinary dead center that is in general machine shop use, but nearly all spinners use the revolving center, shown in Fig. 3. The revolving center is ¾ inch diameter (without taper) and about six inches long, and is fitted into the socket in which it runs; this socket is, in turn, fitted to the taper hole in the tailstock. At the bottom of the hole in the socket are two steel buttons, hardened and ground convex on their faces. These buttons act as ball bearings and reduce friction to a minimum.

Forms and Chucks for Spinning

The shape of a shell made by spinning is dependent on the form or chuck upon which the metal is spun. Forms are used for plain spinning where the shape of the shell will permit of its being readily taken from the form after the spinning has been completed; but when the shape of the shell is such that it will not "draw," as the molders say, it becomes necessary to employ sectional chucks, similar to the one shown in Fig. 5. Generally speaking, spinning forms are made of kiln dried maple. After being bored and threaded to fit the lathe spindle, the spinner turns the maple block to agree with a templet shaped in outline to the sample shell. When no sample is furnished, the templet must be laid out from the sketch or drawing; in either case proper allowance is made for the thickness of the stock. When large quantities of shells are to be spun, all alike, the form is sometimes made of lignum vitæ. Another method is to turn the maple form small enough so that one shell may be spun and cemented to it and then this metal-cased form is used to spin the balance of the shells.

For continuous spinning, forms are made of cast iron or steel, which of course makes a most satisfactory surface to spin on and gives indefinite service.

A sectional or "split" chuck, as it is sometimes called, is, as the name implies, a spinning chuck or form which may be taken apart in sections after the shell has been spun over it. As before stated, this class of spinning chuck is only used when the finished shell could not be removed from an ordinary form after spinning. After a shell has been spun over a sectional chuck, the shell and the sections of the chuck are together pulled lengthwise from the core of the chuck. Then, starting with the key section, it is an easy matter to remove each section from the inside of the shell. As the sections are removed, they are replaced upon the core, slipped under the retaining flange and the chuck is ready for spinning a new shell. The whole operation of removing and replacing the sections of a chuck takes less time than it does to tell it, and, as the sections are of different sizes, it is easy to replace them in the proper order. Like other forms, sectional chucks are made of wood or metal, according to the requirements of the job. The core and retaining ring are first made from one piece and then the sections are turned in a continuous ring and split with a fine saw. In some cases it is necessary to add a small piece to the last section to make up for the stock lost in splitting the sections.

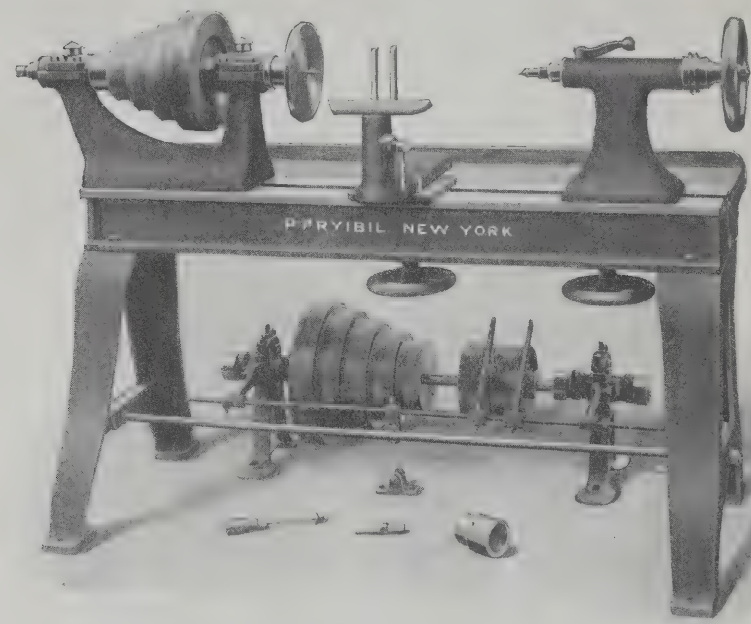


Fig. 2. Spinning Lathe

Another kind of sectional chuck, known to the trade as a "plug" (shown in Fig. 7) is used extensively in some shops in cases where the shell must have projections or shoulders at both ends, and no bottom to the shell is required. In making the plug, which is always in two parts, the first half is turned to take the shell from one end to the center of the smallest diameter. Into the end of this part is bored a hole to which is fitted the end of the second part, which is afterwards turned to fit the shell. Over this two-part plug the shell is spun; then the bottom of the shell is cut out and the first half of the plug removed thus allowing the shell to be withdrawn. The first part is then replaced and the plug is ready for use again. Fig. 6 shows a method of spinning difficult shells that ordinarily would require a sectional chuck. The shell shown at the left of Fig. 6 is first spun as far as the bulged part on an ordinary form that ends at this point. Then after annealing, it is replaced on the form and while another operator holds the wooden arm, supported with a pin in the T-rest, the spinner forms the metal around the bulge-shaped end of the arm. The arm, being stationary on the inside of the shell, acts as a continuation of the spinning form, and by this method as good a shell is obtained as could be spun with a sectional chuck.

For spinning operations upon tubing or press-drawn tubes, steel arbors are generally used. Tubing may be readily spun upon an arbor and it can be reduced or expanded to comply with the shape of shell required much more quickly than the shell could be spun from the blank.

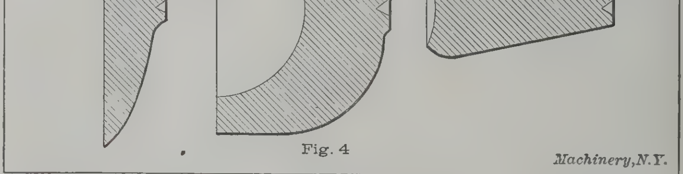
Followers

For holding the sheet metal blank to the spinning form, a block of wood known as the follower, is used (see Fig. 4). Followers are made to suit the shape of the work with which they are to be employed, always being made with the largest possible bearing on the work; thus a shell with a flat bottom twelve inches in diameter would be turned with the aid of a follower having an 11¾-inch face; while a shell with a 4-inch face would take a follower with a 3⅞-inch face. All shells do not have flat bottoms, consequently, in spinning such as do not, it becomes necessary to employ hollow followers. Hollow followers have their bearing surfaces turned out to fit the ends of the forms with which they are to be used. In practice, the blank is held against the end of the spherical form with a small flat follower until enough of the shell has been spun to admit of the hollow follower being used. All followers are made with a large center hole in one end to receive the revolving tail-center.

In starting to spin a difficult shell it sometimes happens that the necessarily small follower will not hold the blank. To prevent this slipping, the face of the follower is covered with emery cloth. Often, however, on rough work, the spinner will not stop to face the follower, but will make a large shallow dent at the center of the blank; the extra pressure required to force the metal against the form will usually overcome the slipping tendency.

Hand Tools

Hand tools, in great variety, form the principal asset of the spinner's kit. Spinning tools are made of tool steel forged to the required shapes, and are hardened and polished on the "business" end. The round steel from which they are made varies from ½ inch to 1½ inch in diameter, according to the class of work upon which they are to be used. The length of a spinning tool is about 2 feet, and it is fitted into a wooden handle 2 inches diameter and 18 inches long, making the total length of the handled tool about 3 feet, as shown in Fig. 8. As the spinner holds this handle under the right armpit, he secures a great leverage upon the work and is better able to supply the physical power required to bring the metal to the desired shape.



Figs. 3 and 4. Revolving Center and Three Types of Followers

The commonest and by far the most useful of the spinning tools is the combination "point and ball" which together with a number of other tools, is shown in Fig. 10. This tool is used in doing the bulk of the spinning operations—for starting the work and bringing it approximately to the shape of the form. Its range of usefulness is large on account of the many differ-

ent shapes that may be utilized by merely turning the tool in a different direction. Next in importance comes the flat or smoothing tool which, as the name implies, is for smoothing the shell and finishing any rough surfaces left by the point and ball tool. The fishtail tool, so named from its shape, is used principally in flaring the end of a shell from the inside, "spinning on air" as it is sometimes termed. This tool is used to good advantage in any place where it is necessary to stretch the metal to any extent, and its thin rounding edge proves useful in setting the metal into corners and narrow grooves. Other tools are the ball tool which is adapted to finishing curves; the hook tool, used on inside work; and the beading tool which is needed in rolling over a bead at the edge of a shell when extra strength or a better finish is desired.

When much beading of one kind is being done, a large heavy pair of round-nose pliers (Fig. 11) with the jaws bent around

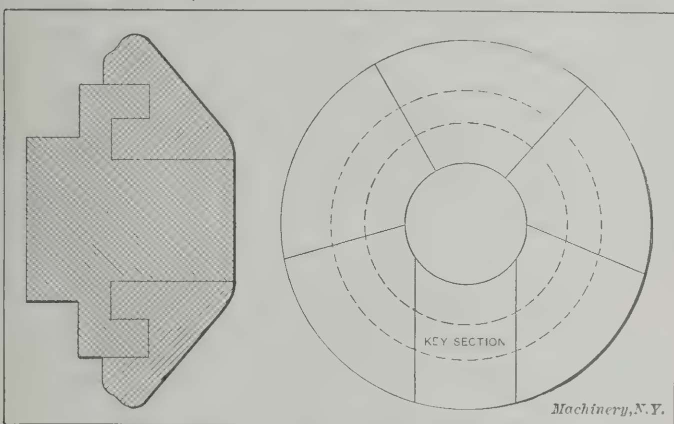
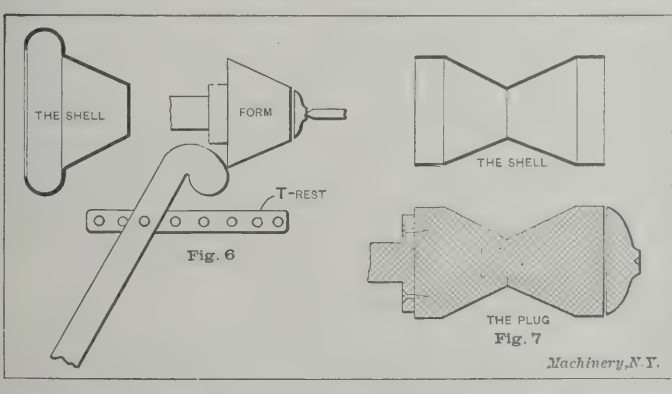


Fig. 5. Sectional Spinning Chuck

in a curve and sprung apart enough to allow for the thickness of the metal proves to be a handy tool. After the edge of the shell has been flared out to start the bead, the pliers are opened enough to admit the metal and then closed and the stock guided around to form the bead as far as possible. In this way the larger part of a bead is rapidly formed; one jaw of the plier acting as a spinning tool and the other corresponding to the back-stick. During this operation, the pliers are, of course, supported by being held against the T-rest.

Closely allied with these spinning tools are two other tools (also shown in Fig. 10) known as the diamond point and the skimmer. The diamond point is for trimming the edges of the shell during the spinning operation and for cutting out centers or other parts of the work. The skimmer is for cleaning up the surface of a shell, removing a small amount of metal in doing so, the amount depending upon the skill the spinner used in the spinning proper.

When the bottoms are to be cut from a large number of shells and it is necessary that they be cut exactly alike, a tool



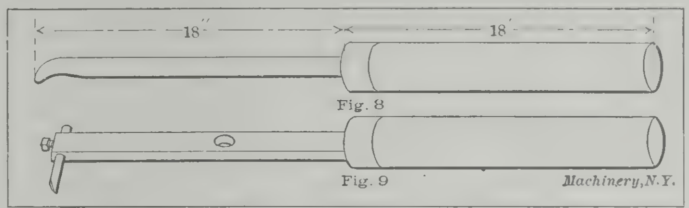
Figs. 6 and 7. Quick Method of Spinning Difficult Shell without Sectional Chuck, and Spinning on Plugs

known as a swivel cutter is used. This tool (see Fig. 9) is simply an iron bar with a cutter on one end, which swivels near the center around a pin in the T-rest; thus by a slight movement of the arm the cutter is brought up to the work, cutting a piece from the shell of exactly the same size each time.

The Spinning Operation

In order to make clear the successive steps in spinning, let us briefly consider the making of a copper head-light reflector, and the way the work is handled when a few hundred pieces are to be made.

By trial spinning, the size of the blank required for one of the reflectors is determined, and with the square shears the



Figs. 8 and 9. Handled Spinning Tool and Swivel Cutter

copper sheets are cut into pieces an eighth of an inch larger each way. These squares are then taken to the circular shears and cut to round shapes ready for the spinning lathe. The spinning form, of kiln dried maple, is screwed to the spindle and the belt thrown to that step of the cone pulley which will bring the speed nearest to 1,200 revolutions. From the stock room a follower is selected whose face will nearly cover the bottom of the form. It is now "up to" the spinner. Holding a blank and also the follower against the end of the form, he runs the tail-center up to the center in the follower just hard enough to hold the blank in place. Then, starting the lathe, he centers the blank by lightly pressing against its edge a hard wood stick. As soon as it "lines up" he runs the center up a little harder and clamps it in place. Some spinners will "hop in" a blank with the lathe running, but this is dangerous

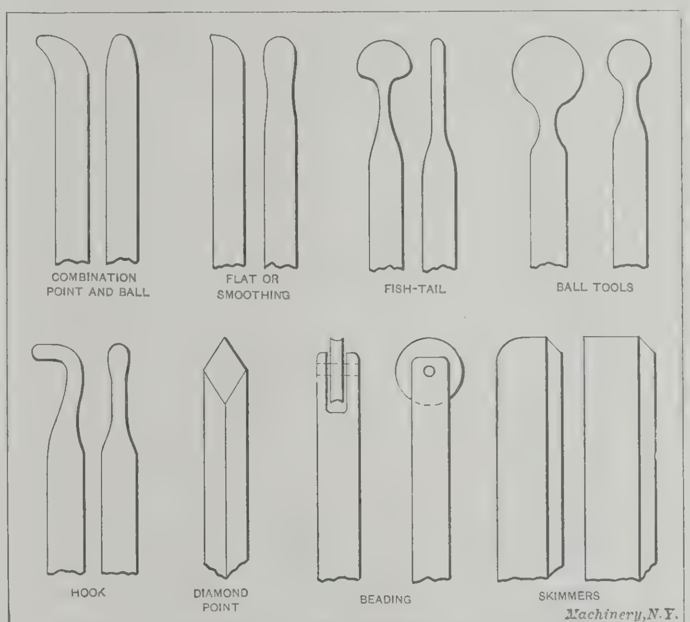


Fig. 10. Hand Tools of Various Forms used in Spinning

practice and sometimes the blank will go sailing across the room. Often this happens in truing up the blank and for this reason it is considered advisable to have a wire grating at the further side of the lathe to prevent serious accidents; for a sheet metal blank is a dangerous missile traveling at the high rate of speed which is imparted to it by the lathe.

With a piece of beeswax (soap is sometimes used for economical reasons) the spinner lightly rubs the rapidly revolving blank and then adjusts the pin in the T-rest to a point near enough to the blank to obtain a good leverage with the spinning tool. Holding the handle of his point and ball tool under his right armpit and using the tool as a lever and the pin on the rest as a fulcrum, he slowly forces the metal disk back in the direction of the body of the form; never allowing the tool to rest in one spot, but constantly working it in and out, applying the pressure on the way out to the edge of the disk and letting up as he comes back for a new stroke. In the meantime his left hand is busy holding a short piece of hard wood (called the back-stick), firmly against the reverse

side of the metal at a constantly changing point opposite the tool. The object of the back-stick is to keep the stock from wrinkling as it is stretched toward the edge of the disk. Wrinkles cause the metal to crack at the edges and for this reason they must be kept from the stock as much as possible.

After a few strokes of the spinning tool have been taken, the shell will appear about as shown at *B*, Fig. 12, and at this point, it is necessary to trim the shell at the edges with the diamond-point tool. Trimming is required because spinning stretches the stock and the resulting uneven edge will cause splits in the metal if it is not trimmed occasionally. As a carpenter is known by his chips, so a spinner is known by the way his work stretches. While the even pressure of a good spinner will stretch the stock very little, the uneven pressure of the inexperienced man will lead him into all sorts of trouble

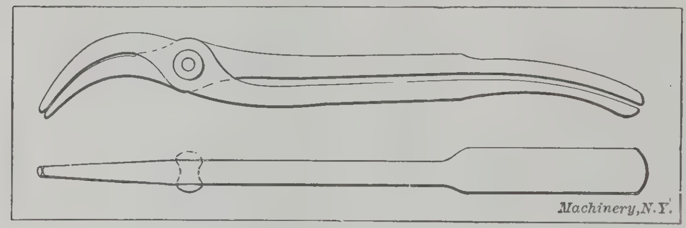


Fig. 11. Spinner's Pliers

on account of the way the stock will go. In either case the metal always stretches least in the direction in which the sheet stock was originally rolled, consequently giving the edge a slight oval shape. In trimming zinc, the spinner holds a "swab" of cloth just above the diamond point, to prevent the chips from flying into his face and eyes—or those of his neighbors. With other metals the swab is unnecessary.

The reflector is now taking shape. With each successive stroke the spinner sets a little more of the metal against the form. Not only does spinning stretch the metal, but it hardens it as well; therefore, at the stage *C* it becomes necessary to anneal the partially completed reflector, which is done by heating it to a low red in a gas furnace. In running through a lot of shells, the common practice is to spin them all as far as possible without annealing and after annealing the whole lot, to complete the spinning.

After replacing the shell upon the form, it is trimmed and worked further along the form, gradually assuming the appearance shown at *D*. At this time, the spinner goes back to the small radius at the front end of the shell and with a ball tool he closes the annealed metal hard down against the form, for the spinning has tended to pull the stock slightly from the form at this point. The body of the reflector is now practically completed and the spinner directs his attention to rolling the bead at the outside edge. Slowly he begins to roll the edge of the shell back, using his hook tool to complete the bead as far as possible and exercising care to keep the back-stick firmly against the metal so as to keep the wrinkles out.

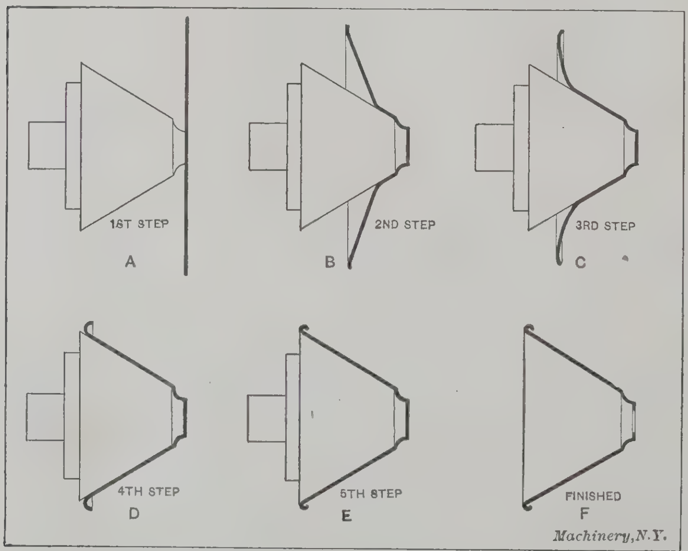


Fig. 12. Successive Steps in Spinning a Reflector

Now, with the diamond point, he gives the edges a final trim and with the beading tool closes down the bead snugly against the rest of the shell, as shown at *E*. Lastly, the swivel cutter is placed in the proper hole of the T-rest and a turn of the tool cuts out the center to the exact size, and the reflector is completed. If any burrs or rough places remain they are easily removed at this time with the skimmer or diamond point and a little emery cloth gives the shell a finished appearance.

Referring to the illustration Fig. 1, *A*, *B* and *C* represent the three most important stages of spinning a shell like that shown at *C*. Annealing is necessary between steps *A* and *B*. *D* is a shell spun upon a form of the plug variety, and *E* and *F* are two views of a shell spun after the method shown in Fig. 6, *F* being the completed shell. *G* illustrates a very difficult shell to spin, on account of the small follower that must be used; the length of the small diameter also adds to the difficulty. *H* shows a shell that must be spun upon a sectional chuck, while *I* is a plain easy job of ornamental spinning. The ball shown at *J* was spun from one piece of aluminum and it is more of a curiosity than a specimen of practical spinning. It was first spun over a form that would leave one-half of the ball complete and the stock for the other half straight out like a short tube. Next a wooden split chuck was made, hollowed out to receive the finished end of the ball and the open end was gradually spun down and in until the ball was complete with but a 1/16-inch hole at the finish. This hole was plugged and the hollow ball was done.

While the operation of spinning is a comparatively simple one to describe, it is not easily learned, and to-day good all-around spinners are hard to find. The limits of accuracy are not as closely defined as in straight machine work, but there are times when good fits are absolutely necessary, as in cases where two shells must slip snugly together. In this article we have taken up only the plain every-day kind of spinning, and were we to follow its work in the gold and silversmith's trade, we would see it evolve into a fine art. In order to insure really good work coming from the spinning lathe, there is a wide range of knowledge that the spinner must have. That knowledge may be brought together and summed up by a single word—*judgment*.

* * *

A STEAM BOILER INCIDENT

Seventeen years ago an enterprising farmer living near Boston purchased a portable steam pump to water his farm. Every summer he has had one of the young men in the neighborhood run it, under the supervision of Mike, the foreman, whose word was law. This summer the boiler leaked so badly that the facts came to my attention. The boiler tubes became so overheated and loosened that there was not a single one which was tight. In former years when they leaked badly, Mike, with a hammer and chisel, would calk them until they were fairly tight. Several years ago the steam gage was stolen, and since that time the "engineer" estimated the pressure by the rate the pump worked with the throttle wide open. How he estimated it when the pump was not working was not made clear to me. The water used in the boiler was the same as that used in the pump, and it came from a dirty frog pond. Small fish and eel grass were continually thrown out of the discharge nozzle of the pump and the natural inference was that they were just as frequently thrown into the boiler. The water glass was so dirty that even if there had been any water in it it could not have been seen; as Mike explained, "It was so stuck up with mud that you couldn't ever depend on it."

Once (long ago) Mike opened a hand hole to clean out the boiler, but as he said, "there was such a mess in there that it would have taken a whole day to clean it out, and what was the use, since it was running all right as it was"—and the mud stayed in there. In all these seventeen years no repairs have been made to the boiler, it has never been inspected, the inside has never been cleaned, its safety valve and steam gage (when it had one) have never been tested, and it has never had anyone with a license to run it. In spite of all this, the owner refuses to have any repairs made, saying that "it isn't worth it, and as long as it will pump water, let it alone and don't fool with it."

E. M. S.

MANUFACTURING AUTOMOBILE EQUALIZING GEARS*

A TYPICAL EXAMPLE OF GOOD DESIGN AND SHOP PRACTICE

RALPH E. FLANDERS†

There is always some question in the mind of the editor as to the interest of his readers in descriptions of typical shop operations. There are occasional operations of particular interest owing to the accuracy required, the novel principles employed, or unusual difficulties to be overcome; about such material there is no doubt. This present article, on the other hand, deals with operations which do not present these unusual or spectacular features, yet the writer feels that they have a value derived from the fact that they are closely related to the operations which produce the bulk of the product of the machine shops of the country; for that reason they should attract the attention of mechanics interested in accurate and economical work. In the particular case with which this article deals, we are able to describe and adequately illustrate the operations from beginning to end, for making a complete, compact machine unit—a differential or equalizing gear for automobile use. The completeness of the job gives it a suggestive value that would not be offered by a series of miscellaneous operations, however interesting. The value of this description, however, does not depend on its completeness

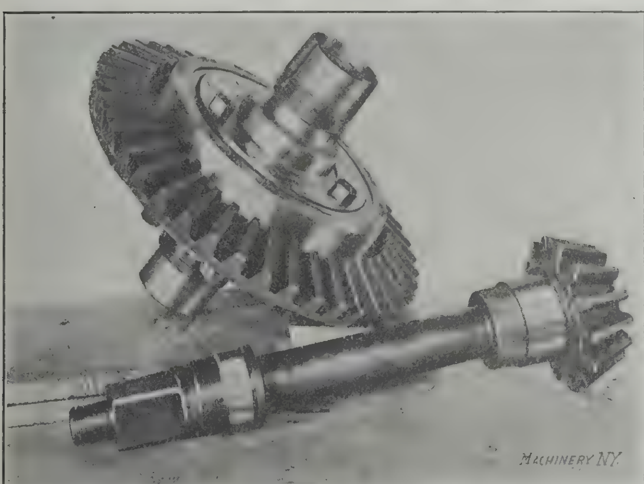


Fig. 1. The Equalizing Gear Complete, with Bevel Gear and Pinion, as used in the Stevens-Duryea Automobile

alone, as many of the specific shop operations give evidence of a high degree of manufacturing ability.

Description of the Equalizing Gear

Figs. 1, 2 and 3 show assembled, dismantled and detail views, respectively, of an equalizing or differential gear, designed by Mr. A. A. Fuller, of the Providence Engineering Works, Providence, R. I. The determining feature of this design is the necessity for getting a maximum of strength and effectiveness in a minimum of space—coupled, of course, with reasonable cost of manufacture. This problem was attacked by scientific analysis. It was possible, without great difficulty, to obtain reasonable strength in the casing which contains the equalizing gearing. The crucial point was in the design of the equalizing gears themselves. In determining the proportions of the gears, curves were drawn showing the strength of the teeth for lay-outs of varying pitch and number of teeth, arranged to be contained within a casing of a given diameter. The strength and bearing area of the pivots, and the strength of the pinions as limited by the thickness of the shell between the bottom of the tooth and the bore, had also to be reckoned with. The tooth shapes were not confined to standard forms, but various pressure angles and heights of addendum were investigated. By comparing the curves for various possible designs, a certain pitch, number of teeth and shape of tooth for the various gears were found for each diameter of casing, so proportioned that if any of the dimensions were changed, the mechanism became weaker instead of stronger. These proportions, worked into a design satisfactory in other particulars, have been adopted as standard, and the makers feel confident that it is impossible to enclose in the same space gears of greater strength than they are offering in the design illustrated herewith. As this confidence is based on mathematical calculations and has been further tested by many months of experience, it seems reasonable that they should hold to it.

Referring particularly to Fig. 3, the mechanism is contained within case *B* and covers *A* and *A′*. It revolves in the rear

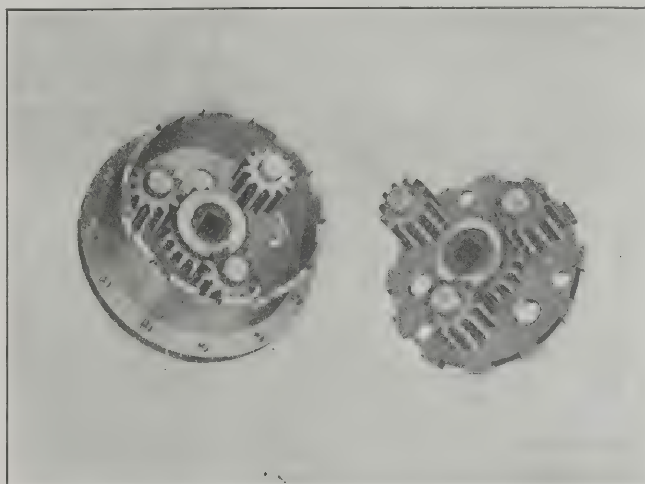


Fig. 2. A Small Size of Equalizing Gear Dismantled to show Construction

axle gear casing on ball bearings, mounted at the ends of casings *A* and *A′*, and the driving bevel gear is carried on the periphery of case *B*, to which it is clamped by hex-head screws *H*. The pivots *E* are riveted into the flanges of covers *A* and *A′*, three in one side and three in the other. These pivots carry pinions *F* and *F′* meshing with gears *C* and *C′*; the latter run in bronze bushings *D* and *D′* forced into the two covers, and are provided with broached square holes by which the floating wheel shafts are driven. As will be seen in Fig. 2 in connection with Fig. 3, gear *C* meshes with pinion *F′*, which also meshes with pinion *F*, the latter in turn engaging gear *C′*. Thus, when gear *C* is turned, gear *C′* is revolved in the opposite direction, and *vice versa*, thus forming a spur gear differential mechanism.

Attention may be called to some of the features which make for strength in this design. It will be seen, for instance, that

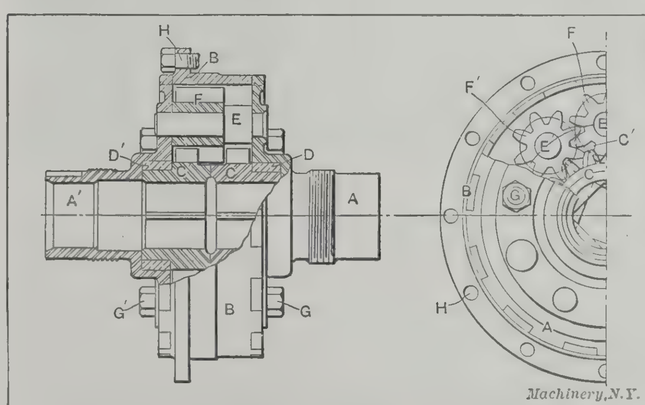


Fig. 3. Details of Construction of the 7-inch Equalizing Gear

the gears have teeth of special shape and of very coarse pitch and few numbers of teeth. The pinions have eight teeth and the gears sixteen each. In designing the mechanism by analysis, as described, it was found that this construction was necessary for strength. Older designs of this kind, more commonly met with, in which the pinions are smaller in proportion to the gears, have repeatedly proved their weakness by breakage.

Mention should also be made of the solid way in which the parts composing the casing are fastened together. The casing *B* is provided with tongues locking into the grooves cut in covers *A*, so that the strain of transmission is taken on these interlocking members and does not depend on the bolts, dowel pins or similar parts. So far as this torsional strain is con-

* For further description of this type of differential gearing, see October number of Machinery, page 84, engineering edition.
† Associate Editor of Machinery.

cerned, the casing is as strong as if it were made of solid metal—an impossible construction, of course. Through bolts and nuts G and G' clamp the whole casing firmly together.

The proper meshing of the bevel gears can be controlled by shifting the whole casing axially in its bearings. Nuts are mounted, for this purpose, one on the threaded diameter of A and the other at the same point on A'. By loosening one and tightening the other the teeth of the gears can be brought more closely into contact, or *vice versa.*

The provisions for oiling should be noted. The casing in the rear axle is provided with a bath of oil in which the bevel gears run. Three holes cut in the exterior of B (not shown in Fig. 2, but visible in the detail views of the operations in Fig. 4, and at the right of Fig. 5, where these holes are being drilled) admit oil from this bath into the interior spur gears. Pivots E and pinions F are grooved, as are also gears C and C', permitting a flow of oil through the whole structure, kept in constant motion through the revolving of the parts.

In describing the manufacture of this device we will take up each part in turn. The manufacture of the bevel gears will not be described in detail, as their design is determined

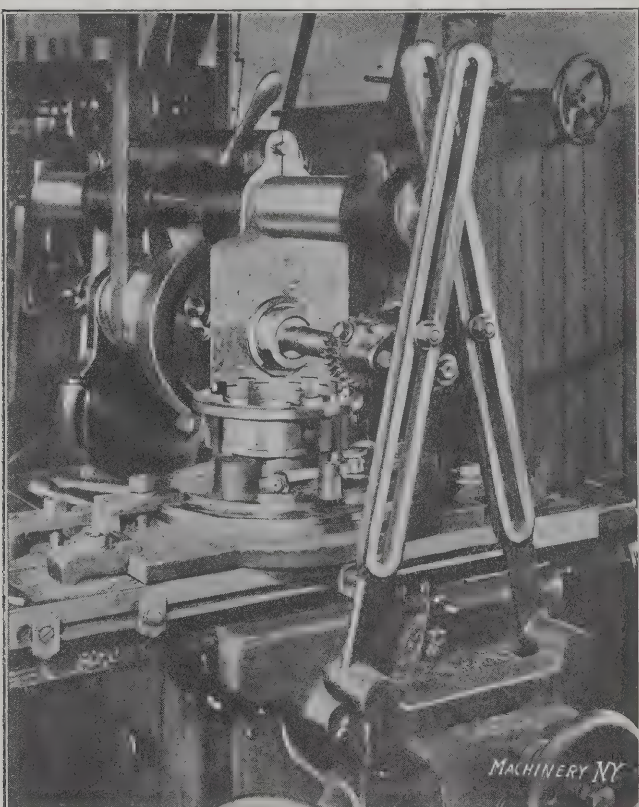


Fig. 4. Milling the Driving Tongues in the Gear Case—Second Operation

by the maker of the car in which the device is to be installed. The first part to be considered will be the gear case, shown at B in Fig. 3.

Operations in the Manufacture of the Gear Case

The case is made from a malleable iron casting on which the first operation, naturally, is that of snagging to remove fins, gates, etc. The second operation is performed in the Jones & Lamson flat turret lathe, of which large use is made in this shop. The casting is placed in the chuck of the machine with the flange outward. In this operation the hole is finished to size, the flange is turned, and the projecting end is faced. The regular equipment is used for this purpose, the only special tools being gages for the inside diameter of the hole and the outside diameter of the flange.

In the third operation, performed in the same machine, the part is grasped by the finished flange in special soft chuck jaws, which have been turned in place to fit the diameter they are to receive. This gives assurance that the work done in this operation will be true, within reasonable limits, with the cuts previously taken. Regular flat turret lathe equipment is used for this operation as well, suitable gages of simple construction being provided. The next operation, shown at the right of Fig. 5, is drilling the three holes which admit oil to the interior of the case. This jig is of the simplest possible construction, consisting of a knee with a turned seat on which the work is placed, and an overhanging lug carrying a drill bushing. A clamp provides for holding the work, and a plug, entering a suitably located hole in the seat, provides means for indexing the second and third holes drilled, from the one previously completed. The other operation shown in this engraving will be described later on.

The tongues which interlock with the grooves in covers A, A' (see Fig. 3) have next to be milled. The fixture for doing this is shown in use in Fig. 4. It consists of a base provided with an index plate and a revolving table, by means of which

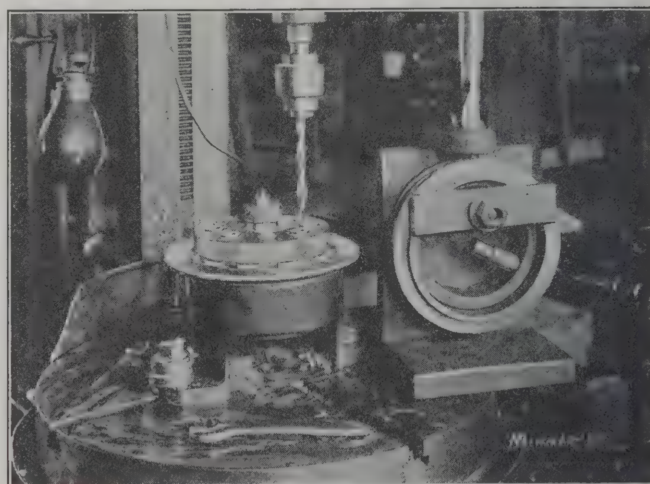


Fig. 5. Drilling the Three Oil Supply Holes in the Case (see Fixture at the Right), and Drilling the Bolt and Pivot Holes in the Cover

the work may be indexed step by step to cut the various tongues. These are shaped by straddle mills which form the opposite sides of the tongues parallel, so that they fit into corresponding grooves milled into the covers by a straight-sided cutter. In the operation illustrated, tongues have been cut on one side of the casing, which is located in its seat in the fixture by the interlocking of these tongues with grooves provided to receive them as shown. This assures alignment of the cuts on each edge of the case. In the first operation the uncut edge of the work is simply set down onto this seat. It is held down by three clamps, provided with noses which enter

Fig. 6. The First Turret Lathe Operation in Finishing the Gear Case Covers

the three holes drilled to admit oil to the interior of the mechanism.

It is interesting to see the expertness with which the operator cuts out these tongues. The automatic feed is set at the highest point practicable when cutting the full depth. As this would be less than the maximum possible when the cutter is entering the work, he begins with a hand-feed at a considerably higher rate, throwing in the automatic feed when the cutter gets down to work. Although the machine is of modern construction, the workman was feeding it all the belt could handle, and was evidently then not satisfied with its performance, as he was engaged in tightening up both the countershaft and driving belts during the time of the writer's visit.

The gear casing is now complete except for certain operations performed on it in assembling, as described later.

Operations on the Gear Case Cover

The gear case covers are made from machine steel drop forgings. After the snagging, the first operation is the simple one of putting a 1½-inch hole through the center of the forgings. This is a drill press operation and is merely done to remove stock, it being, of course, impracticable to form the hole in the forging. It is next clamped by the rim with the

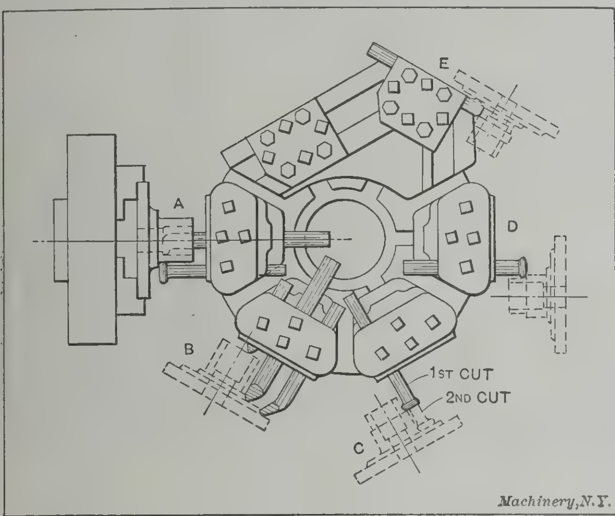


Fig. 7. Lay-out of Tools on the Flat Turret Lathe for the Operation shown in Fig. 6

hub projecting, in the chuck of the flat turret lathe. This first turret lathe operation is shown in Figs. 6 and 7, the latter diagram indicating the arrangement of the tools.

The first cut is shown at *A*. An outside turning and boring tool, acting in conjunction, rough turns the hub and rough bores the hole. At the next station, *B*, three tools simultaneously face the end of the hub and the two surfaces of the flange. Two cuts are taken with these, one for roughing and one for finishing. A third cut is taken with the same tools fed axially against the work to form the two grooves in the face of the flange, as most plainly shown in Fig. 3. At the third station *C*, another turning tool removes the stock on two diameters of the hub, two cuts being taken. At *D* a finishing cut is taken over the smaller diameter, while at *E* a form tool

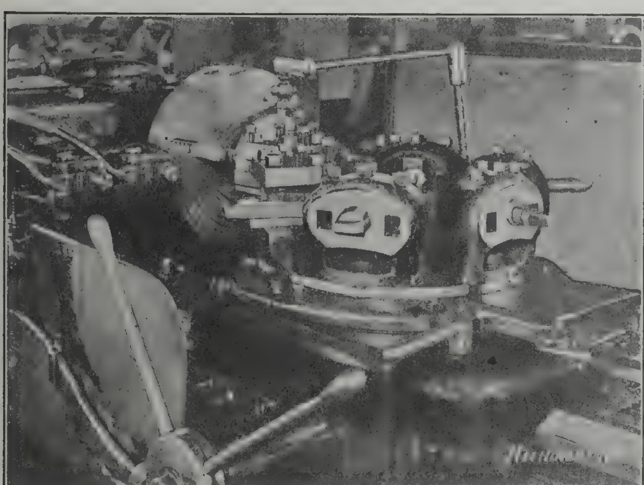


Fig. 8. Second Operation on the Flat Turret Lathe, using Special Jaws

shapes that portion of the hub extending from the threaded diameter to the flange. This operation is completed in about 18 minutes.

In the second operation (see Figs. 8 and 9) the completed end of the piece is grasped in soft jaws turned to fit the surface they grasp, assuring true running of the surfaces made in the two operations. The tool at *A* bores out the large diameter of the hole, which is for clearance only. The reamer at *B* finishes the small diameter to size. The tool at *C* faces the flange, taking two cuts, one to rough out stock and the second to bring it to size. A flat-nosed tool at *D* finishes the flange. The tool at *E* roughs out the counterbore, while that at *F* finishes it. This latter tool is fed directly in, boring the diameter of the counterbore to size until the bottom is reached, when the sliding head is fed outward, so that the same tool faces the bottom of the counterbore. The finishing is thus done by turning cuts instead of forming cuts, giving a higher degree of accuracy. Work of this kind shows the flat turret lathe to very good advantage. In the lay-out of tools shown in Figs. 7 and 9, there were probably no special tools of any kind required, with the exception of the form tool *E*, the rest being stock turning tools of the kind which forms the regular equipment of the machine. It may have been necessary in some cases to give the tool a knock of the hammer on the blacksmith's anvil to crook it in one direction or the other, but nothing more would be needed. The cross sliding head and the multiple stops come into play in such operations as those at *B* and *C* in Fig. 7, and *F* in Fig. 9, giving each separate tool a wide range of usefulness, especially when it is so made that it can be used for both turning and facing jobs.

Hand vs. Automatic Machines

Of course there are all sorts of opinions about such matters, but in the question of hand versus automatic machines, this company believes that the conditions favor the use of the hand turret lathe in its work. The simplicity of the tooling is an important factor on contract work. The management can never be sure of the long continuance of any job, so that anything approaching costliness or elabora-

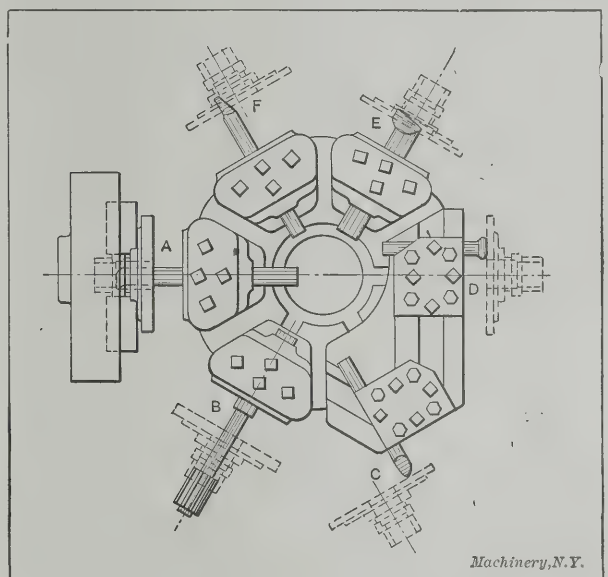


Fig. 9. Lay-out of Tools in the Operation shown in Fig. 8

tion is prohibited. Furthermore, it is reasonably certain that one hand machine will turn out more work than one automatic, particularly when, as in this shop, there is an inducement, such as the premium system, for the workman to get the most possible out of his machine. He is constantly changing his feeds and speeds as the varying diameters, depths of the cut and condition of the tool require. He is thus able to take heavier cuts without injuring his cutting edges than would be possible without constant personal supervision. Probably three or four changes are made in each operation to one that would be made by an automatic machine. As another advantage, this greater production of the machine means a much less capital outlay per dollar of output.

It certainly does keep the operator busy to get the most out of one of these lathes. There is no possibility of his running more than one machine, on this particular work at least. Cuts are taken very rapidly and changes of feed and speed follow each other in constant succession. There is a line of demarkation at the point where the intensity of production on the part of the hand machine and the lower capital charge on machines, buildings, stock, etc., balance the higher output per man and the consequent lessened labor cost for the automatic machines. In accordance with their judgment, some shop managers will draw the line at one point and some at another. It is fortunate for the builders of both types that all men do not come to the same conclusion when reasoning from the same premises.

Gear Case Covers—Continued

In Fig. 10 the milling machine is shown rigged up to cut the driving slots in a pair of the gear case covers. The two are mounted together face to face on a special iron arbor, having a driving tail cast integrally with it in place of the usual separate dog. A formed cutter is used which shapes the bottom of the slot to the true radius of the inside diameter of the casing *B* (see Figs. 3 and 4) assuring a tight fit. This operation and that shown in Fig. 4 have to be done to close limits with good indexing plates, only 0.001 inch variation being allowed on the thickness of the slot and the tongue. This means that in order to make a good fit the dividing must be very accurate. In the cases the writer saw assembled, these parts drove together with a very little gentle urging from a lead hammer. Not much of anything else seemed to be required. In Fig. 11 is shown a jig for drilling the bolt and pivot holes in the gear covers. It is of simple construction, the cover being supported on four legs and located by a central spindle over which it is dropped and by which it is clamped, an open side collar and nut being used as shown. The bushing plate set over the work is located to bring the

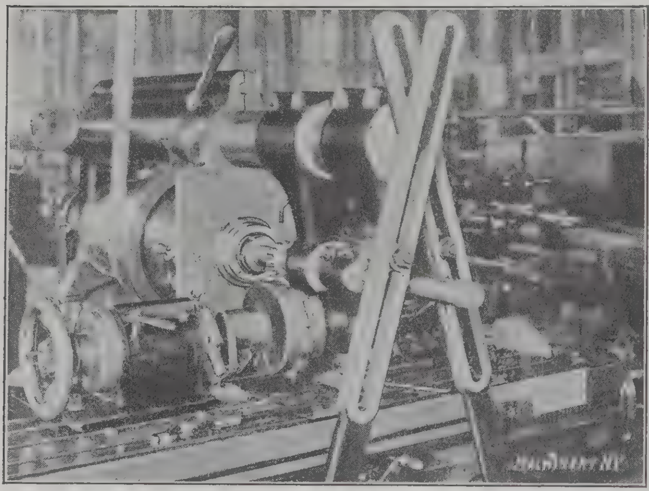


Fig. 10. Milling the Driving Slots in a Pair of Gear Case Covers

holes in right relation with the slots, by a tongue entering the latter. In the next operation the covers are mounted on a special face-plate, as shown in Fig. 12. This face-plate is surfaced true in place and is provided with an expansion mandrel centered integrally with it. The gear case is slipped on over this mandrel and tightened in place by turning on a wedge screw. While thus held the countersink in the outer end of the hub, the seat for the ball bearing, and the threaded diameter are turned. The thread is also cut. This is done by the Rivett-Dock threading tool, shown in operation. These

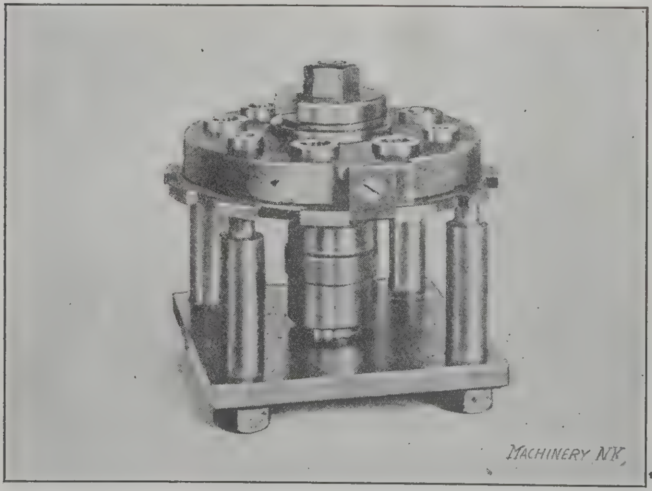


Fig. 11. Jig for Drilling the Bolt and Pivot Holes in the Gear Case Covers. Another Jig for the Same Operation is shown at the Left of Fig. 5

operations of countersinking, turning and threading, altogether, average about eight minutes time for each piece. When the turning was in progress, the writer timed the lathe and found it was making 250 revolutions per minute, which gives about 150 surface feet per minute for the cutting speed.

A fixture and mill of obvious construction are used for cutting the keyway by which the inner race of the ball bearing is made fast to the hub.

Equalizing Pinions, Studs and Gears

The studs *E* are made on the Gridley automatic turret lathe with the regular tools and equipment, the job being, of course, one of the everyday variety for this machine. Oil grooves are milled, and then the burrs are removed by hand. The

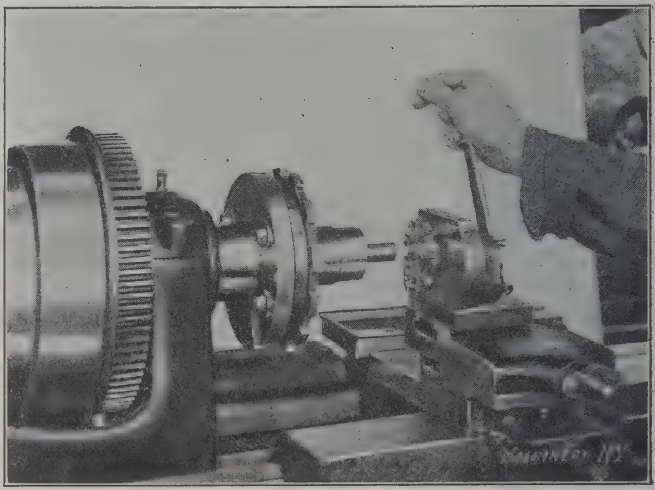


Fig. 12. Threading the Gear Case Covers with a Rivett-Dock Threading Tool

equalizing pinions are drilled, reamed and turned on the flat turret lathe. The ends are squared accurately to length in the engine lathe.

The equalizing gears are cut off to length from the bar stock (all gears and pinions are made of chrome nickel steel) and are bored, reamed, faced and filleted at the large end in the Jones & Lamson machine. The hole is reamed accurately to size so as to furnish a guide for the broach in forming a square hole. This is done on the La Pointe machine at a

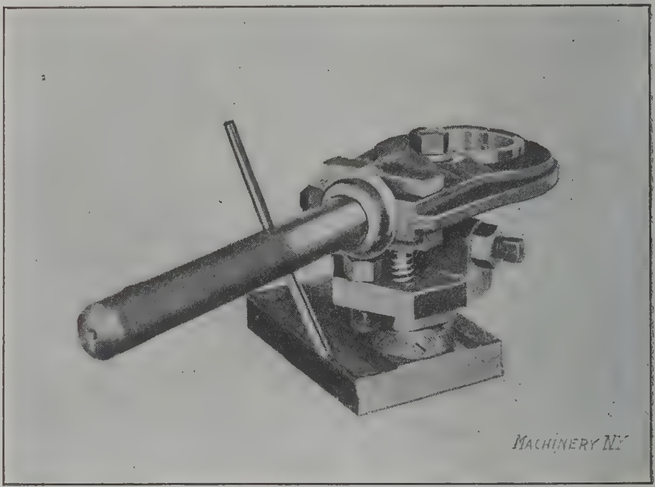


Fig. 13. A Special Fixture for Cutting Oil Grooves in the Equalizing Gear Bushing

single pass of the broach, which is a long one, having some 24 inches or thereabouts of cutting length. The outside surfaces of the gear are then rough turned on a square expansion chuck somewhat similar to that shown in Fig. 12 for the gear case cover, except, of course, that it is mounted on a square surface instead of a round one. In the next operation it is finish turned all over.

The spur gears and pinions are cut in a triple head indexing device which is one of the standard attachments on the Brown & Sharpe milling machine. Three cutters operate on three gangs of work simultaneously. By giving special shapes to the gears and by being very careful both in centering the cutters and setting them to the proper depth, first-class results have been obtained—better than are needed in fact, since normally these gears are stationary or nearly so, being in operation only when rounding corners, in the case of a deflated tire on one side, or the slipping of a wheel in the mud. After removing the burrs by file and reamer, the gears and pinions are hardened by the regular process recommended by the makers of the steel (the Carpenter Steel Co.), with

such modifications as the blacksmith of the shop has found advisable.

The equalizing gear bushings D and D' are cut out from a bronze bar in the flat turret lathe, being turned and bored complete to size. A stack of them are placed on the Mitts & Merrill keyseater for cutting the internal oil grooves. The radial oil groove is cut on the interesting tool shown in Fig. 13. This device is a modification of the principle used in attachments for slotting screws with a saw held in the speed lathe. The knurled handle shown controls three motions. By screwing it in or out the bushing is tightened or released in the jaws by which it is held. Tripping it up or down drops the bushing away from or brings it up toward the revolving cutter, while springing it to one side brings the bushing out from under the cutter where it can be removed without interference. A wire finger locates the work with relation to the internal groove previously cut.

Assembling

The operation of assembling the parts to make the complete mechanism includes some operations worthy of notice. In Fig. 14 is a case assembled with its two covers and dropped into a cast-iron reaming stand, where it is held from revolving by the projecting pin shown, which enters one of the three

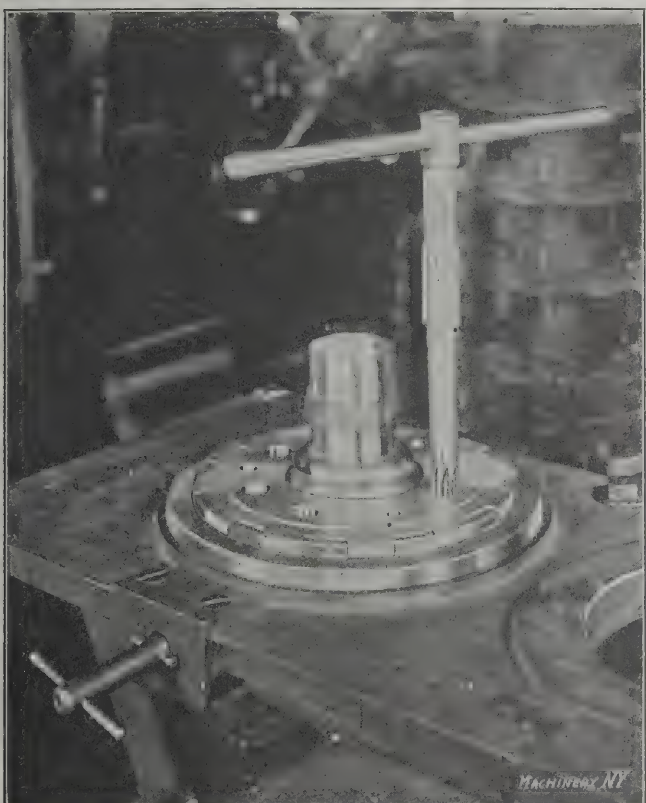


Fig. 14. Line-reaming the Pivot Holes in the Assembled Gear Cases and Covers

holes in its periphery. A line reamer is used, giving assurance that the two bearings in each cover will be true with each other. After this line reaming the covers are marked, numbered and burred so that the same parts will be reassembled together.

Studs E are next riveted to the covers, three on one side and three on the other, a hand hammer being used for this purpose. The ends of the rivets are cupped to facilitate this operation. The pinions are assembled on the studs, three on each side. The bushings are pressed into the covers under the arbor press, and burred. The equalizing gears C and C' are dropped into place and the whole structure is then assembled. A square wrench inserted through the bore into the squared hole in C, permits the gears to turn until they are all engaged. Three bolts and nuts G and G' are now passed through, binding the whole solidly together.

It is of extreme importance in the quiet running of an automobile that the bevel gears run true. For this purpose the bevel gear seat on the outside diameter of the casing is not finish turned until it has been assembled as described. To do this, the mechanism is mounted on the lathe on large centers, bearing on the countersinks in A and A'. These countersinks, being formed in the same operation with the ball bearing seats and the threads, are true with them. After this turning and facing, a jig fitting on this accurate seat is used for drilling the flange holes through which screws H pass to fasten the bevel gear to the casing.

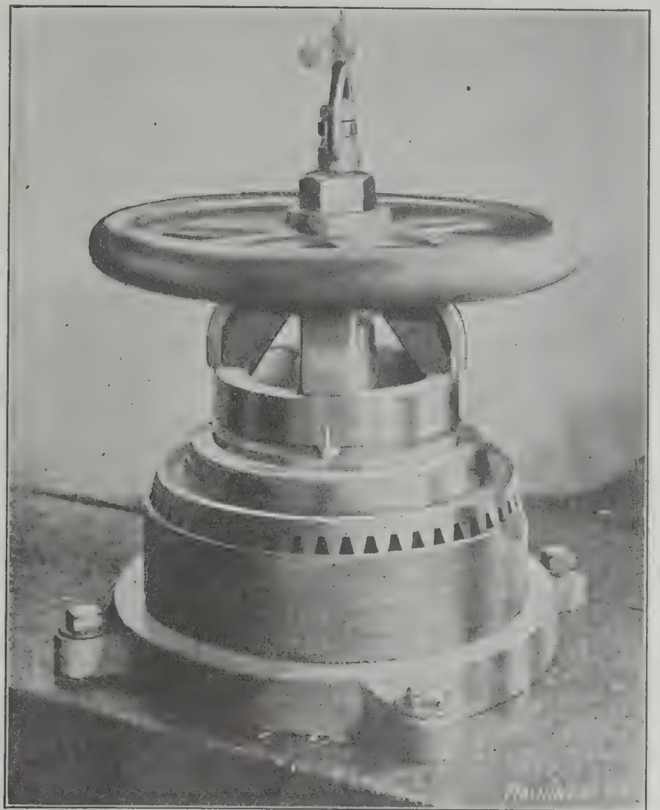


Fig. 15. A Convenient Fixture for Assembling the Gears on the Gear Case

The gear is pressed into place in its seat by a simple contrivance which illustrates the demand for conveniences created by the premium system. On the bench in front of the

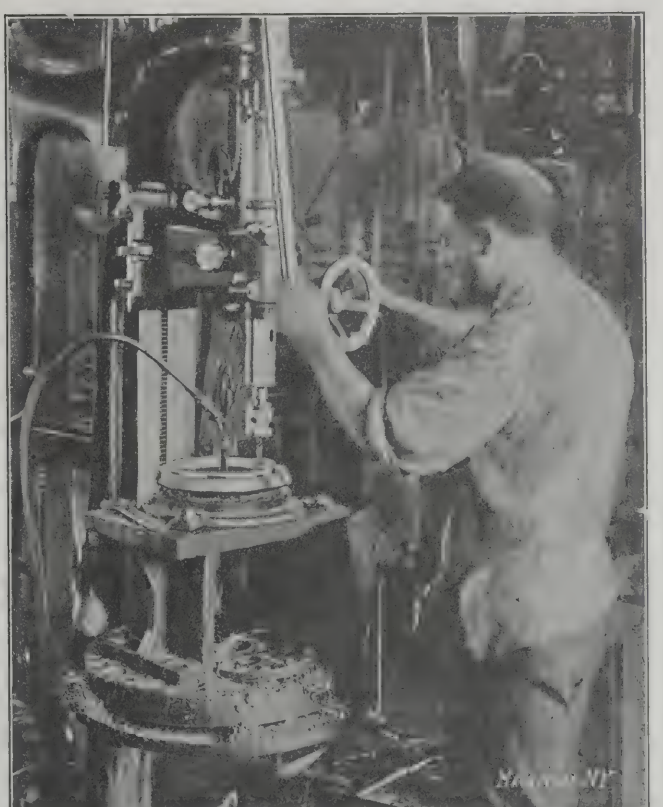


Fig. 16. A Tapping Operation and Operator with a Remarkable Record—75,000 Blind 5-16-inch Holes in Chrome-nickel Steel without breaking a Tap

workman is a cast-iron seat (Fig. 15) in which the bevel gear is placed face downward. The complete differential mechanism is then placed over the gear in a position to be forced down into it. The workman now reaches up above his head and brings down the hand-wheel, clamping screw and clamp

shown, which is suspended by a counterweight so as to move freely up and down and remain stationary in any position. Entering the screw in the nut in the base of the device and turning the hand-wheel, forces the casing down into the gear and thus completes the assembling. The tap bolts are now put in and are wired through holes drilled through their heads, to prevent them from turning. This completes the making of the equalizing gear.

A Good Tapping Record

While the making of the bevel gear has not been described, it will not do to pass over one of the operations met with. This is the operation of tapping the holes by which the gear is held to the flange. These holes are 5/16 inch in diameter and 13/16 inch deep and are blind, being tapped to a bottom and not through. The tapping is done in a Cincinnati drill press (Fig. 16), using an Errington friction chuck. Tapping in chrome-nickel steel by power is, it will be agreed, no "fool of a job." One of the difficulties met with is the tendency of the metal to seize the tap and break it when backing out.

The operator shown broke many taps in becoming familiar with his job, but since he has gotten into the swing of it, he has tapped 75,000 of these blind holes in chrome-nickel steel without breaking a tap. The credit for this record must be divided between the man, the machine, the chuck and the tap, but there is enough to make a respectable showing for all four. It may be remarked that, in accordance with the well-known total depravity of inanimate things, the workman had the misfortune to break a tap a few minutes after the conversation in which I learned his record. His increase of effectiveness was obtained with practically no change in the tools or methods, being due simply to the training of his judgment in the feeling of the tap, and in the use of excellent tools. It might be said that a firm of the highest reputation for accuracy and for skill in manufacturing, had asked ten cents a hole for the job. This operator runs two taps in each of the twelve holes in a gear, twenty-four holes in all, in from 15 to 18 minutes.

Tests on the Finished Casings

Of course, the object that was aimed at in designing these equalizing gears for sale to manufacturers of automobiles, was to give them such strength that some other part of the machine would break first. In order to find out whether or no this result had been obtained a number of tests were made in the laboratory of the engineering school of Brown University.

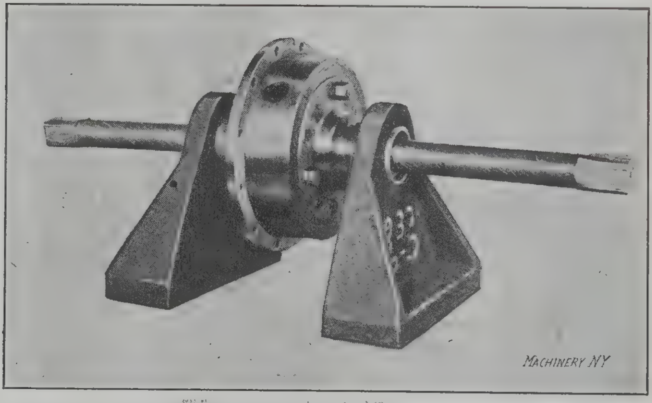


Fig. 17. A Completed Equalizing Gear, Set up for Testing to Destruction by Torsional Stress

In Fig. 17 the casing is shown as mounted in brackets for a torsion test, the power being applied through 1-inch, 3½ per cent nickel steel shafts specially treated. These failed at 20,300 inch-pounds, twisting through 800 degrees before rupture. Samples of broken shafts are shown in Fig. 18, and give some idea, in combination with the figures just given, of the excellence of the material used in these shafts. No damage of any kind was found inside the gear casing, the mechanism being unbroken and running as easily and smoothly as before.

The Providence Engineering Works feels perfectly confident in offering these equalizing gears to automobile manufacturers, after its experience with them in the laboratory, and their trial in the road conditions met with by the thousands which have been placed on the market.

EXPERIENCES OF A YOUNG TOOL-MAKER

T. COVEY

After Jim had completed his end mills ready for the hardening operation (as described in the August number), he turned them in and was given stock for some spiral surfacing mills, with instructions to make them like a sample given him, and to ream the holes 0.005 inch small so as to leave stock to grind out after the mills were hardened. He proceeded to chuck the pieces in a lathe and face one end and bore the holes. When a 1⅛-inch hole had been bored about an inch deep in the first piece, Jim began to have trouble. The steel was hard and tough, and the drill, which was somewhat worn, though apparently sharp, would not cut. Instead it would screech and stick until it stopped the lathe. After many efforts in grinding the drill and trying different speeds, he finally

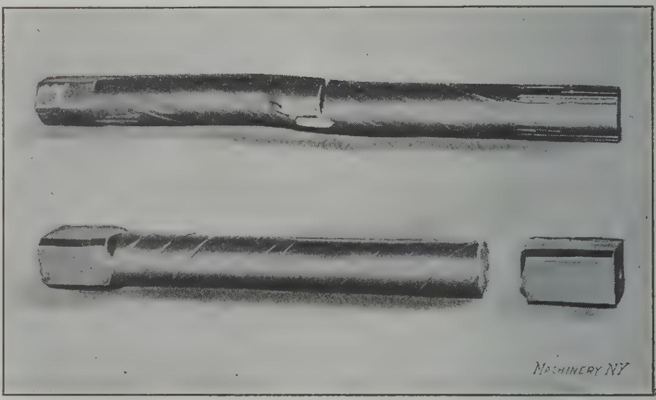


Fig. 18. Condition of Shafts Broken in Tests shown in Fig. 17; the Gears were Uninjured

remarked to a man by the name of Anderson who was working on a machine near him, that that was the worst stuff he had ever tried to drill.

"What is the matter with it?" Anderson asked.

"That's what I would like to know; I can't get a drill to cut it," said Jim.

"Let's see your drill. Is that the best one you could get?"

"Yes. The boy at the window said the rest of that size were out. I guess he thought that was good enough for a kid to use anyway."

"Well, the clearance is gone for an inch at least. Do you know that you can grind a drill so that it will cut a hole larger than itself?"

"I never noticed it in particular."

"Well you can. You just grind one cutting edge longer than the other, so that the point is off center and the drill will cut large.

"I ground it on the drill-grinder and supposed it was all right."

"It probably would be if it was a good drill. Get a boring tool and bore out that hole as far as you have gone with the drill, at least a thirty-second of an inch larger and I will fix this drill so that it will work."

Jim got a tool and bored out the hole. When Anderson came back and handed Jim the drill he said, "There, that will cut large, and in that way it will have clearance on one side. Of course it can't bind much unless both sides rub. I think you will have no trouble in getting it to drill those pieces. I don't say that it is good practice to grind drills that way; a drill properly made and in good condition will clear itself and drill a hole to size, but when a drill is worn out it is no good, and for that reason you could not spoil it. It is a question, however, whether grinding a good drill off center would spoil it or not. Now if you are not accustomed to working tool steel, I can give you a pointer that may save you trouble. When you wish to ream a hole in tool steel, leave more stock for the reamer to cut than you would for cast iron or soft steel; a good thirty-second of an inch will not be too much. If possible use one of the special reamers that we have made for this work as they have more teeth and more clearance or reversed taper. The ordinary commercial reamer, while probably the best for general shop use, will ream too close to size for this job, and it also tends to stick in tool steel."

"I am glad you told me about it," said Jim. "I was of the opinion that the less stock left for the reamer to cut the

better, and I thought one kind of reamer as good as another. This drill is working all right now, and I guess I'll get a hole through *this* piece anyway."

Jim got his first piece bored and reamed without further mishap, but in making a starting hole for the drill in the next piece, he broke his tool by pushing it into the work before he got it central. George happened along about that time and Jim asked him for the loan of his centering tool until he could get his re-forged.

"A centering tool is something that I do not have, and very seldom use," said George. "What do you want to do? Start your drill? I'll show you how to start it without a centering tool. The first thing you want to do is to face the work off square so that the shape of it will not crowd the drill off the center; then place the drill in the chuck so that its cutting edges are in a horizontal position, and start it into the work, so!"

"But it is not running true," said Jim.

"We'll fix that; we will take this lathe tool, which is pretty square across the back end, and put it in the tool-post with the back end forward and clamp it fast, and then bring it up so that it bears against the drill close to the work; then feed the drill in a little, and crowd the tool against it until it looks as if it were central. When the tool is backed away, if the drill still looks central, go ahead; if not, repeat the operation until it is central. You see it saves the time and trouble of grinding and setting a centering tool and for ordinary purposes it is just as good."

As Jim was finishing up his lathe work, Mr. Corbin came along and picking up the sample mill said, "Jim, I want those mills for heavy roughing work and this sample mill has too many teeth; don't cut them like that but cut them about ⅝ pitch." Just then his attention was called to something else and he gave Jim no further directions. Jim was at a loss to know just what he meant but he did not like to let him know it. As Anderson was working near, he told him that he had been instructed to cut the teeth on his mills ⅝ pitch, but did not understand just what Mr. Corbin wanted.

"Well," said Anderson, "in this case ⅝ pitch means ⅝ of an inch from one tooth to the next."

"But why didn't he tell me how many teeth he wanted? How am I to know how many teeth he wants?"

"He would have to calculate the number before he could tell you, and he left that for you to do."

"I suppose it appears like an easy matter to you but I don't know how to go about it."

"Multiply 3.1416 by the diameter of your blank and divide the result by ⅝. That will give you the number of teeth. What is the diameter of your mills?"

"About four inches."

"Well, 3.1416×4 is 12.5664, and $12.5664 \div$ ⅝, or 0.625 is a little over 20. Twenty teeth is what you want."

"Where did you get the 3.1416 from?"

"Why, 3.1416 is the ratio of the circumference to the diameter. That is, the circumference of a circle whose diameter is 1 would be 3.1416 and the circumference of a circle whose diameter is 4 inches would be 4×3.1416. If you want to demonstrate the truth of this take a piece of cord, pass it around one of your blanks and cut it off so that it goes around once with the ends just touching; take it off and measure it and you will find that it is very nearly 12½ inches long. Then if you wish to carry it further, cut the cord up in pieces ⅝ of an inch long, count the pieces and you will find 20.

"That is rather interesting, but is a machinist or toolmaker expected to have a knowledge of all such things?"

"I can only answer that in this way. I have noticed that the amount of a man's pay generally depends on his ability, and that toolmakers with a good knowledge of geometry and trigonometry combined with ability to do good accurate work are nearly always paid the best rate of wages."

With that Anderson went to grind a tool and Jim looked around for a milling machine to finish his job in. He found a small one idle and started to set it up when Mr. Corbin saw him and said, "That job of yours is too heavy for that machine; cutting spirals is pretty hard on any machine and you would be apt to strain this little fellow and impair its accuracy. Use that No. 4 over there—it may be more awkward to handle but it is suitable for the work."

Jim set the machine up for cutting the spiral according to the instructions on the table with the machine, and then as George was working near, he asked him to look it over to see if he had it right. George looked at the gears and referring to the table said they were all right; also the angle was right. Taking hold of the handle that moves the table he tried to turn it but it would not move. "You have not unlocked the index plate so that it can turn," he said. "You should always work the table back and forth once or twice to make sure that everything is free and working properly before starting the machine on a job of this kind."

"What angle cutter would you use for these?" Jim asked.

"Use a regular spiral mill cutter; they have a 12-degree angle on one side and an angle of 40, 48, or 53 degrees on the other. You want a right-hand cutter."

Jim obtained a cutter, a 1¼-inch mandrel, and a dog. On trying the mandrel into one of the blanks, he found, of course, that it was too large, and he went to Mr. Corbin and asked him what to do about it.

"We have hardened and ground mandrels 0.005 inch under size," said Mr. Corbin, "also reamers and expanding arbors of 1-inch, 1¼-inch, and 1½-inch sizes for work that is to be hardened. A great many shops ream mills and such work to size and depend on the hardening operation to close the holes sufficiently to allow them to be finished by lapping, but we make a great variety of mills that are of irregular shape and unless there is an equal amount of stock around a hole throughout its length it is apt to come back from hardening with one end of the hole larger than the other, making it a difficult and long operation to lap out the hole; and sometimes there is not enough stock to finish. For this reason we leave 0.005 inch stock in the holes of all work that is to be hardened, except the smaller sizes and special cases, and grind them out to size."

Jim took the mandrel back and asked for one 0.005 inch small, which he found fitted all right. When he got his cutter on the arbor and the work in position he began to realize that it was going to be a difficult matter for him to start a cut in the proper place for the simple reason that he did not know how. After thinking about it for awhile he came to the conclusion that it was beyond him. Looking around to see whom he could get to help him out of his difficulty, he saw a man by the name of Joe Waters who was working on a shaper near by and seemed to have lots of time at his disposal as he had just started a cut. Jim went to him and asked him if he would show him how to start a cut properly on one of those blanks.

"I'll try to," said Joe. "A good many fellows put a mill on a mandrel, put it between the centers and set their cutter to that, and I am afraid that there are some men that have laid claim to the title of toolmaker for a good many years that could do it no other way. I sometimes wonder what they would do if they had no sample to go by. You have your cutter on wrong; the side with the 12-degree angle should be next to the machine. Now get a surface gage and set the scriber to the height of the centers of the machine. Generally you will find a line on the footstock center that indicates this height, but where there is none, put the work between the centers and set the surface gage scriber as near to the center as you can guess and scribe a line on both sides of the work, index the work half around and scribe another with the gage at the same height; the center will then be just half way between the first and last lines. The gage is then set as near this point as possible and the operation repeated. When the gage is at the right height, you will be able to make only one line with the scriber on turning the index head half around. Now get some of that acid and rub it on the ends of your blanks so that you can see the lines that you scribe—use a little piece of waste moistened with it."

"Say! that is funny stuff," said Jim; "what is it?"

"It is nothing but water with bluestone, which is the same as sulphate of copper, dissolved in it, with a very small amount of nitric acid added. When it is applied to iron or steel it deposits a thin coat of copper on it. Now move the table of

the machine along until the end of the work next the foot-stock center is just half under the arbor on which the cutter is mounted and let it stay in this position for the present. How many teeth are you to cut?"

"Twenty," said Jim.

"That means just two turns of the index handle for each tooth, and we will put the index pin in the 21 hole circle. Now scribe a line across the end of your blank next the footstock center, index for one tooth and scribe another, and so on until you have gone clear around the blank. This may seem unnecessary, and it is, so far as starting the cut is concerned, but we need two and the rest serve as a check on the indexing and also would show if the work should at any time slip on the mandrel. When you scribe the last line mark it with a pencil or piece of chalk and turn the index handle 10 turns bringing this line on top. Now the edges of the teeth you are going to cut should be perfectly radial the same as the lines you have just scribed, and the side of the cutter that is to make these edges is to be at an angle of 12 degrees with a vertical line. Let the line that you have marked and turned to the top represent the first one of these edges that you are going to make; now what we want to do is to set this line in position so that the 12-degree side of the cutter is parallel to it, and as the 12-degree side is next to the machine, the line on top must be turned toward the machine 12 degrees; 360 ÷ 12 is 30, so we must turn the index head 1/30 of a turn, and to do this the index handle must be turned 1 1/3 turn, or one turn and seven holes in the 21 hole circle. There! Now the line you have marked is parallel to the 12-degree side of the cutter, and as your cutter is just half over the end of the blank that has the lines on it you have only to move the saddle in or out until the cutter is over the space between the line you have marked and the one next it at the top. Start the machine and raise the work up under the cutter until the 12-degree side cuts up to the line you marked and the other side comes about 3/64 inch from the next line. If you wish, you can keep away from both lines until you have taken a cut to see how it looks and satisfy yourself that it is coming all right. You should note the reading on the dial of the handle that operates the knee, and every time you finish a cut drop the work down away from the cutter before you run the table back for another cut, then raise it up again, after running it back, until the dial reads the same as it did before it was disturbed. If you don't lower the work, the backlash in the gears will allow the cutter to cut up the sides of the teeth and make a bad job. You will not need to set up your machine but once for this lot of mills as they are all of the same size and have the same number of teeth. It would be well, though, to index each blank and lay out each tooth with the surface gage, and when you have scribed the lines all around move the index handle 1 1/3 turn and one of the lines will come in the proper place providing your blank sets with the end next the footstock center just half under the cutter when you are laying out the teeth. Very few tool-makers bother to lay out the teeth before milling, but it is a good idea for a beginner to do so as it gives an opportunity to watch the cutter when it is starting into the blank on each tooth, and if a mistake is made in indexing, or if the blank slips on the mandrel, it will be readily noticed and may be remedied before much, if any, damage is done."

"Thank you for the information," said Jim. "It's a good thing for me that I don't have to cut teeth on the ends of these mills or I would be in trouble again."

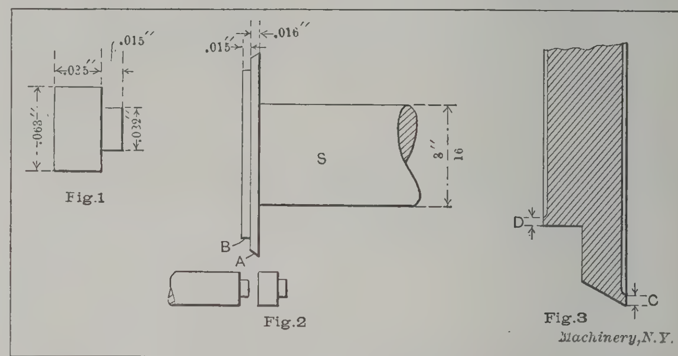
"That is not such a difficult job," replied Joe. "We have cutters in the tool-room that have a 12-degree angle on one side and 65 degrees on the other, which will generally cut the teeth in the ends that have a negative rake, and we usually cut the teeth in the end that would be undercut if the form of the spiral were followed, with a regular 65-degree cutter, not bothering to carry out the form of the spiral on this end, although it may be done quite easily where the index head can be lowered enough from the horizontal to bring the lands equal, by swinging the table around enough to bring the spiral in a position at right angles to the cutter (which would be to the same angle as given for cutting the spiral) and feeding the work in a vertical direction past the cutter. Well my cut is over and I will have to get busy."

MAKING PINS FOR IRIS DIAPHRAGM LEAVES

WALTER GRIBBEN*

The brass pin shown in Fig. 1 is used in the iris diaphragm of a camera, one pin being used in each end of each leaf of the iris. A few of these were wanted by a repair shop, or "camera hospital," to use in repairing diaphragms where a few of the leaves were damaged. On account of the limited number wanted, the job would not admit of very much rigging up. The teat left on the end for riveting in the hole in the leaf should be cupped out a little to facilitate riveting, but permission was asked to omit this cup, as by so doing the pins would be cheapened somewhat, and a solid teat was considered plenty good enough for repair jobs, although it might not do when manufacturing.

The pins were made of brass wire 0.063 inch diameter and were to be 0.035 inch long in the body, while the teat was to be 0.032 inch diameter and 0.015 inch long. No screw machine



Figs. 1, 2 and 3. Small Pin used in the Iris Diaphragm of a Camera, and Disk Tool used for Turning it

was available for this job, so it was done on a bench lathe. The details of the fixtures used are shown in the line cuts, but they are not all drawn to the same scale.

A disk tool, Fig. 2, was made of ⅜-inch drill rod. The shank *S* by which it is held, is in one piece with the disk. The part *A* is the cut-off, while the part *B* forms the teat on the next pin to be made. Fig. 3 is an enlarged section through part of the disk tool, showing how the sides were cupped out a few thousandths to make the cutting parts *C* and *D* quite narrow, with the object of making the tool cut more freely and thus throw up less burr on the work.

The halftone engraving, Fig. 4, shows the general arrangement of the improvised apparatus for getting out this job. The iron casting *E* was fastened to the top of the slide rest, and a hole bored in place which eventually held the hard steel bushing that guided the stock. This bushing is held by the set-screw *F*. The rock-shaft *G* is mounted between pointed screws, the one on the left being screwed clear up to the head, while the screw on the right-hand end has a check-nut by which to adjust for a close-running fit without shake. The arm *H*, shown in detail in Fig. 5, is tight on shaft *G*, while arms *K* and *L*, shown in detail in Figs. 6 and 7, are both loose on *G*. The two screws *M* and *N* hold *H* and *K* together, and serve to adjust the disk tool *A* for depth of cut, and thus produce the proper size of the teat on the end of the work, *M* being tapped into *K*, while *N* is tapped into *H*. When *M* and *N* are both tight, *H* and *K* act as one piece. The crank-shaft *O* was made of ⅛-inch Bessemer rod, and it carries two eccentrics *P* and *R*, made of 5/16-inch Bessemer rod with the hole bored off center. Eccentric *P* works in the open slot in the end of lever *K*, and causes the disk tool *A* to alternately move to and from the stock wire. Eccentric *R* works in the closed slot in the end of lever *L*, and causes the upper slide of the slide-rest to feed along after each cut has been made. The feed is accomplished by means of the pawl *U*, the bell-crank *V*, and the stationary rack ratchet *T*, clamped to the lower slide, the regular feed screw of the top slide being temporarily removed. The bell-crank is pivoted to *E* by a shouldered screw *W*, while another shouldered screw *X*, connects its horizontal arm with the end of lever *L*. Screw *X* had to be a rather loose fit in the end of the bell-crank arm, as *V* and *L* vibrated in different planes, but as the vibration was only

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over an arc of a few degrees, no trouble from binding was apparent. The rack T was cut on one of the edges of a piece of angle brass, the pitch of the teeth being equal to the total length of the finished pin plus the width of the cut-off part of the disk tool, or 0.066 inch altogether. The bell-crank was made of two pieces of sheet brass taken from the scrap box and soft soldered together. This may look like a slovenly way of making a bell-crank, but it was quickly made, and held together long enough to do the job, besides having the advantage that the vertical arm could be made longer or shorter by simply melting the solder. The arm carrying the pawl was adjusted in this way until the pawl moved a little more than one tooth of the rack, but not as much as two teeth. As the movement of the top slide is governed entirely by the pitch of the rack teeth and not by the amount of movement of the pawl, any lost motion in the feed works does not affect the length of the pins, unless it amounts to as much as the distance between two consecutive teeth of the rack. The two eccentrics P and R were adjusted around on the crank-shaft until the two movements were correctly timed relative to one another; that is, so the feed did not start until after the disk tool had been withdrawn from the work, and also so that the feed was completed before the disk tool started to cut.

As this work is so small in diameter, it was realized that a high speed of rotation was desirable, both to prevent the formation of much of a burr on the edges of the work, and also to reduce to a minimum the little teat left by the cut-off tool. With this object in view, the high-speed drive shown in Fig. 4, which was originally made to drive an internal grinding device, was changed a little to adapt it to present needs. The drive is shown in section in Fig. 8. It consists of the brass casting A, the upper end of which is slotted and carries the adjustable stud B, on which runs the double wooden pulley C, the large part of which is for a flat belt, and the small part for a round belt from the countershaft. This pulley has screwed fast to it a brass flange and hub D, into which are forced two hard steel bushings, one in each end, leaving on oil chamber between them. The end of the

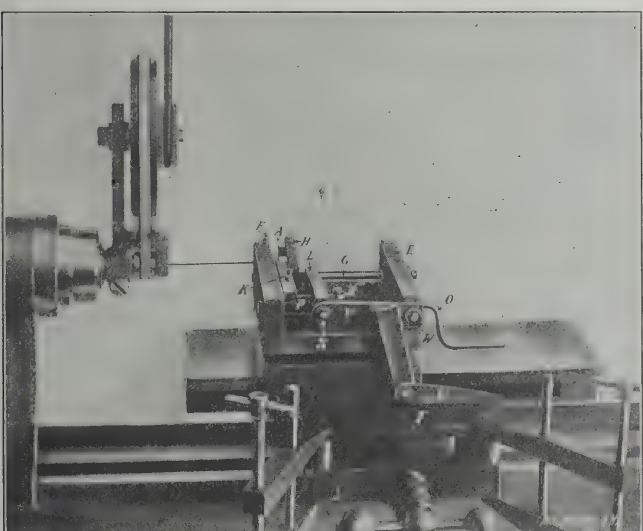
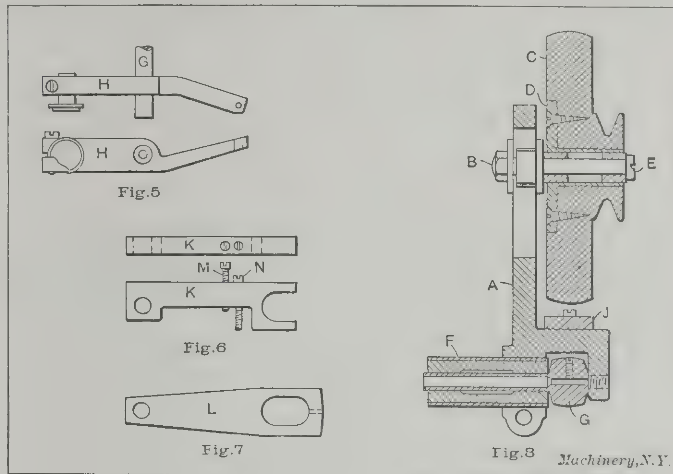


Fig. 4. Bench Lathe Attachment for Turning the Small Pins shown in Fig. 1, at the Rate of Sixty per Minute

stud is tapped, and the large-headed screw E is screwed in tight, which prevents the pulley from coming off. The lower part of A is bored ½ inch diameter, and has a saw cut and pinching screw to clamp it on the piece of ½-inch brass tubing F, which was tinned with soft solder on the inside and then poured full of babbitt metal. After cooling, it was bored 3/16 inch clear through and the ends faced. The middle of this hole was bored a trifle larger than the ends, in order to form an oil chamber. The pulley G also performed the office of a chuck to hold the brass wire of which the pins were made. It is made of ½-inch cold-rolled steel, with a long stem on one side 3/16 inch diameter, this stem being bored ⅛ inch as far as the pulley, and 0.063 inch the rest of the way. A small headless set-screw in G holds the work in place. The part of F that projects to the left is grasped in a ½-inch draw-chuck, and the lathe spindle locked to prevent it from rotating. An ordinary flat rubber band did duty as a belt to connect C and G, but it had this peculiarity, that considerable crowning on the pulleys seemed to have very little effect on keeping the belt in the middle of the pulley face, so a guiding fork J of sheet brass was attached. There seemed to be some structural irregularity in the rubber itself, as there was a tendency for it to crawl to the right when one side of the rubber was next the pulley, but to crawl to the left when the rubber band was turned over.

The mode of operation was to lift the feed pawl and draw the top slide as far to the right as it would go. Then a three-foot length of wire was passed through the lathe spindle and into the hardened guide bushing, in E (Fig. 4), after



Figs. 5 to 8. Details of the Attachment shown in Fig. 4

which the small set-screw in pulley G (Fig. 8) was tightened and the countershaft started. This gave an estimated speed of 10,000 revolutions per minute to G, providing the belt did not slip. Then the crank on the end of O was turned by hand, a finished pin dropping off for each turn, until the top slide reached the left-hand end of its travel, when the power was shut off, the slide moved to the right again, the stock wire released and pulled through until it was in the guide bushing once more. After tightening the set-screw and starting the power, a few dozen more pins could be made at the rate of about 60 per minute, when the stopping and returning to the right had to be repeated. The handle O could be turned much faster than this, but in that case the momentum of the top slide would be apt to carry it a little too far, and thus make the pins of varying lengths, so it was thought advisable not to exceed the rate mentioned. This fixture left the pins with practically no burr on them, and they were all ready for immediate use.

* * *

At the present time when we are prone to assume that everything undertaken in the mechanical field surpasses in magnitude or difficulty of production anything made in past centuries, it is of interest to recall that the so-called Great Bell of Moscow, made in Russia in 1734, is, according to the *Brass World*, not only the largest bell ever cast, but is also the largest casting of any kind ever made. The making of a casting of the size of this bell would startle the world even to-day. A great Chinese bell weighing 120,000 pounds is another example of ancient casting. As far as is known, these bells were cast from metal melted in close proximity to the mold. One or more furnaces capable of melting the required quantity of metal were so arranged that a trough connected the tap hole with the mold, for tapping the metal directly from the furnace into it. As a matter of fact, this method would, even to-day, be the only practicable one for casting a piece of similar size.

* * *

That the gasoline or alcohol engine is destined to be the farmers' future source of power in preference to the horse, seems to be reasonably sure. It now drives his automobile, shells his corn, grinds his cattle feed, pumps his water, threshes his grain and plows his land. Kansas farmers are using traction gasoline engines to haul their plows, and it is claimed that four men with a traction gasoline engine can do as much plowing as twenty men with horses.

DIE SINKING AND SHOP PRACTICE IN THE ARMSTRONG BROS. PLANT

ETHAN VIALL*

The business of the Armstrong Bros. Tool Co., "The Toolholder People" of Chicago, has grown from the almost insignificant product of a very small shop to the immense output of a factory that is second to none in equipment and which holds its own in size with those far in the front rank. This last statement means something, for as a rule, the business of a shop making small tool specialties does not require a large plant. The growth has not been of the mushroom kind, but has been a strong, steady increase, the result of good sound business management pushing a line of tools that were needed and which were made in a first-class manner. The Armstrong brothers have always been good, steady advertisers, but no amount of advertising could have built up the business that they have to-day, had the tools, the material and the workmanship not been right.

Besides the regular line of lathe and planer tools, the company now makes drop forgings and machine shop specialties

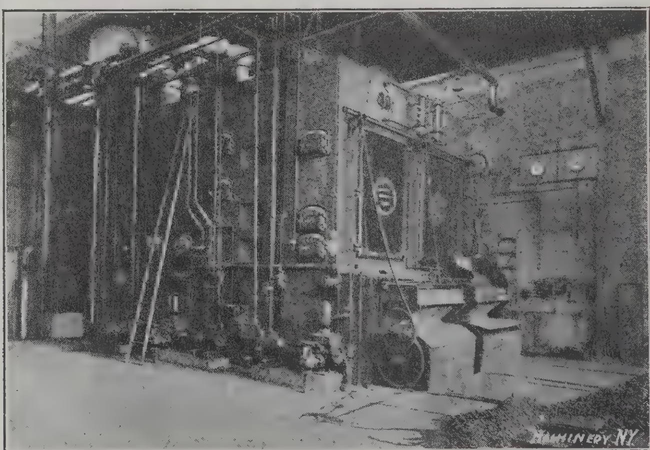


Fig. 1. View of the Boiler Room at the Armstrong Bros. Shop

of several kinds. The factory has its own power and light plant, and the boiler room, a partial view of which is shown in Fig. 1, is a model of neatness and careful planning; it is light, well drained and amply large enough for future expansion. Automatic stokers are used, and the condition in which the place is habitually kept is plainly shown in the engraving, the picture having been obtained one noon when no one knew that it was to be taken, so that no cleaning up for the occasion was possible.

The forge room is partially shown in Fig. 2. The arrangement of alternate steam hammer and trimming press is good. The heating furnaces are also well located, but, unfortunately,

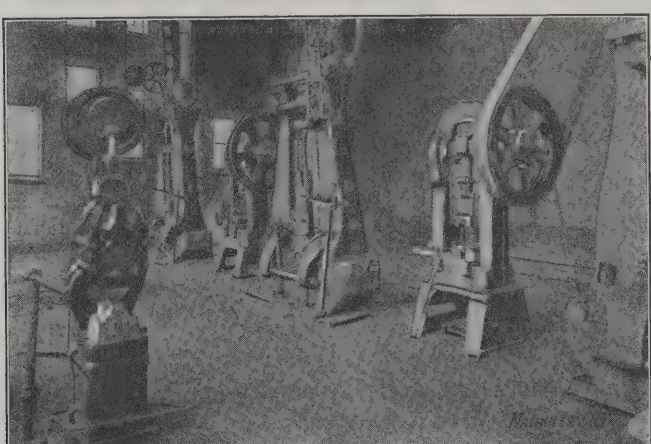


Fig. 2. Arrangement of Steam Hammers and Trimming Presses in the Forge Room

the position from which the picture was taken, would not allow of their being shown. This department, as well as all the others, has been planned with an eye to both present and future needs.

A great many of the articles manufactured, especially the tool-holders, are case-hardened by being packed in large iron boxes with raw bone and charcoal, and heated in furnaces in the usual way. The method of handling the iron boxes is not, however, as common as it might be. These boxes are made with grooves or corrugations on each side, extending the entire length of the box, and a large iron fork, the prongs of which just fit these grooves, and which is swung from a

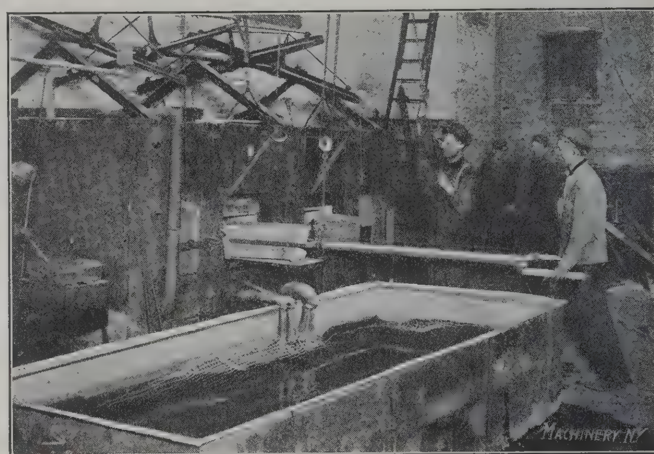


Fig. 3. Case-hardening Furnace and Cooling Tank

traveling tackle, is used to put the boxes into the furnace and to remove them when they are sufficiently heated. When the boxes are removed the contents are dumped into the cooling tank, which is fitted with a screen to keep the parts off the bottom and insure more even and thorough cooling, all of which may be seen by referring to Fig. 3. The screen just referred to, can be easily removed to clean the burnt bone out of the bottom of the tank. When the picture was taken the water was purposely lowered to show the position of the big screen in the tank.

The tool holder set-screws, which are made of tool steel, are heated in a special furnace that heats only the points and

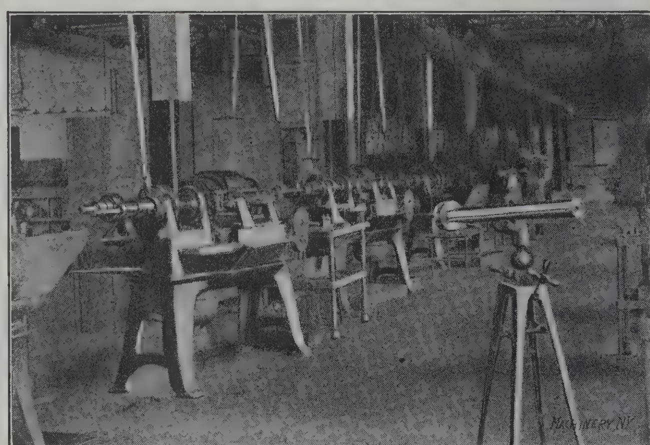


Fig. 4. Battery of Automatic Screw Machines which make the Tool-holder Set-screws

drops them into the hardening bath as fast as the operator can feed them in. The burner of this furnace is the same as that used on a bicycle brazer, and, in fact, the furnace is principally made from the parts of an old brazing stand.

The set-screws just referred to are made by the battery of automatic screw machines shown in Fig. 4. In the foreground is an old universal bicycle vise that is used to hold the big quills while taking out or putting in the spring collets used for feeding the stock. Anyone who has ever run this class of automatics will see the convenience of the old vise, for something of the kind is very frequently needed.

The system used for detailing the dimensions of parts for different sizes of tools of the same class, will be of interest to many, as it saves a great deal of work in the drafting room by making one print do for all sizes. A sample drawing for the six different sizes of spindle and feed sleeves manufactured, is shown in Fig. 5, and for those not already familiar with this method, it will be a revelation in simplicity.

Naturally in a shop depending so much upon drop-forge work, the die making department is one of the most important in the works and is well equipped. This department is in charge of a man of long experience on this class of work,

* Associate Editor of MACHINERY.

though a comparatively young man. One of his remarks hits the drop-forging die problem squarely on the head, and it is that the great difficulty in drop-forge work is not so much in making the die, but in making the metal go into it, meaning, of course, that the breaking down, roughing or bending operations are really the most important and the most difficult to plan out properly. Almost any toolmaker can sink a finishing die from a model, but it takes brains and experience to plan and work out the other parts of the die so that it will work satisfactorily without unnecessary waste of time or material. In planning dies or die parts of especially difficult shapes, plaster of Paris models are often used in order to find the best shape or position for the part to lie in; this is especially important in so planning a die as to get that great desideratum of the drop-forge shop—the finishing at one heat.

be judged from it. For very large forgings such as the C-clamp just mentioned, cast-iron roughing and forming dies are used. The piece is first broken down, bent and rough formed in these dies and then reheated and finished in the tool steel finishing die. Fig. 8 shows a set of wooden patterns for a pair of cast-iron dies weighing 1,600 pounds, or 800 pounds apiece.

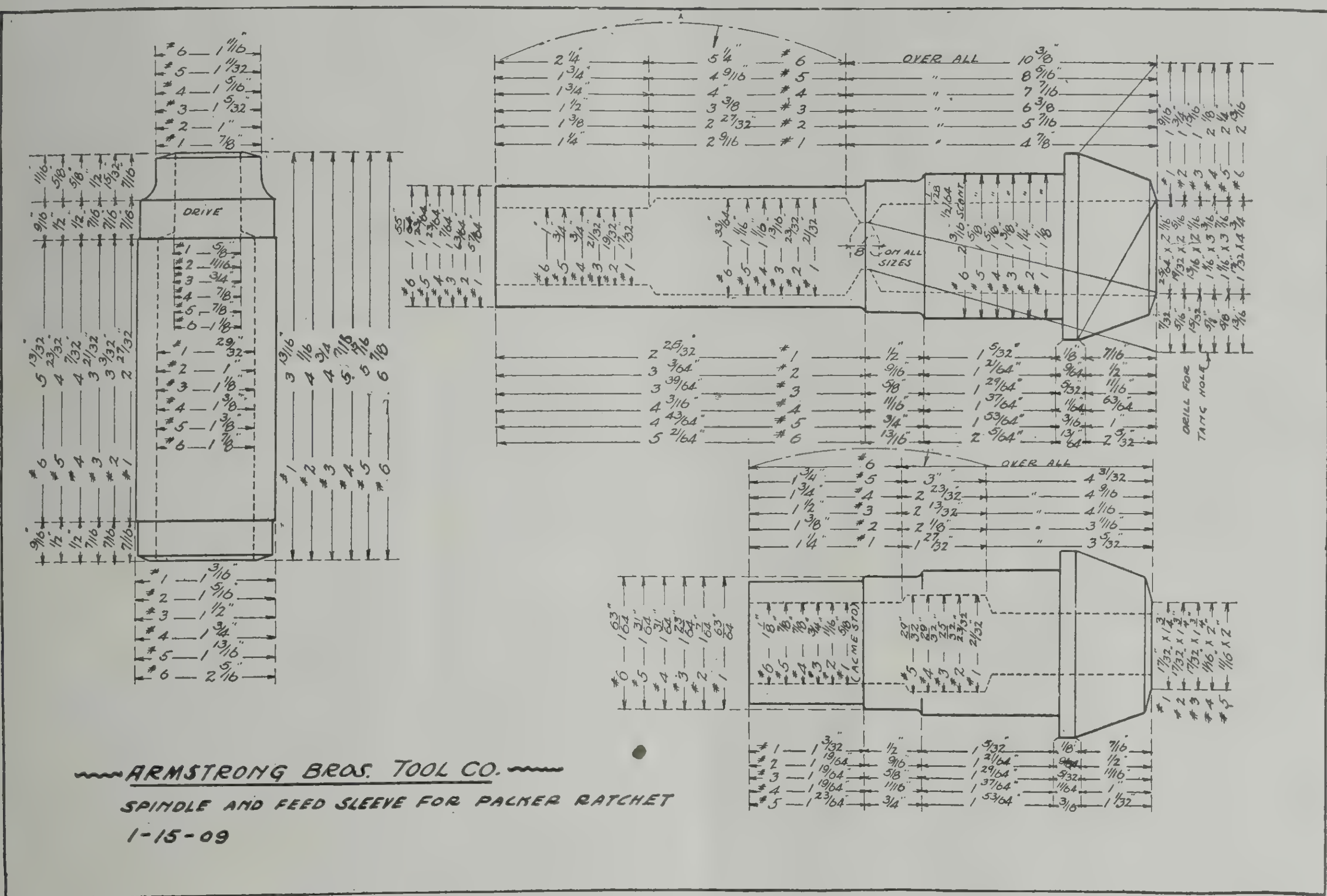


Fig. 5. Drawing giving Dimensions of Six Different Sizes of Spindle and Feed Sleeves

Many small pieces are forged in "pony dies," which are made of a shoe of tool steel two or three inches thick, which is keyed into a heavy cast-iron or cast-steel block. These pony dies are very economical, as one set of shanks can be made to do duty for a large number of shoes, the shoes all being located by dowel pins and keyed in with a taper key, in the same way that the shanks are keyed into the steam hammer anvil and head.

Fig. 6. View of Drop Forgings as they appear when taken from the Dies

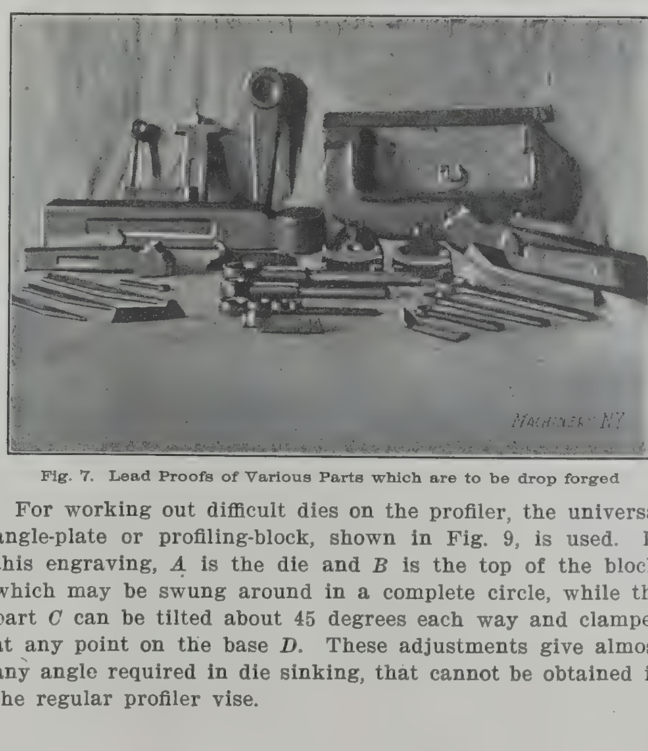


Fig. 7. Lead Proofs of Various Parts which are to be drop forged

Fig. 6 shows a number of drop-forgings, including tool-holders, wrenches, drifts and a C-clamp with the flash still in place. These forgings are just as they came from the steam hammer. A trimmed-off flash is shown on top of the large C-clamp in the middle of the group. Fig. 7 shows a lot of lead proofs of dies for making various sizes of drop-forgings from the smallest to the largest. The big C-clamp shown is 18 inches long and the sizes of the other parts can

For working out difficult dies on the profiler, the universal angle-plate or profiling-block, shown in Fig. 9, is used. In this engraving, A is the die and B is the top of the block, which may be swung around in a complete circle, while the part C can be tilted about 45 degrees each way and clamped at any point on the base D. These adjustments give almost any angle required in die sinking, that cannot be obtained in the regular profiler vise.

A special center-bracket used to steady small mill arbors held in the spindle chuck of the profiling machine while working out cylindrical cavities, is shown in Fig. 10. The mill used is of the same diameter as the cavity wanted, and it affords a quick, sure way of getting a perfect cavity of the right size.

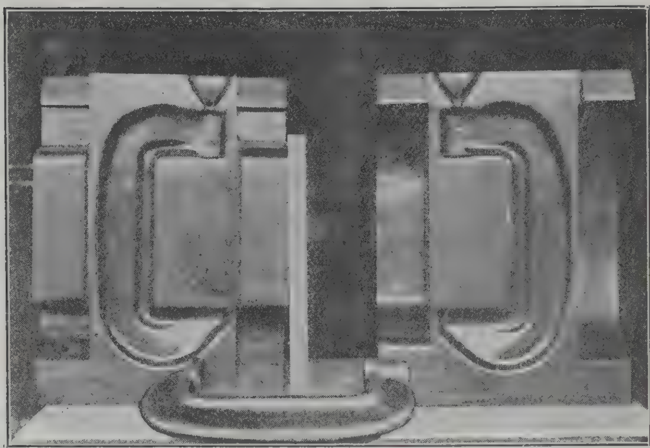


Fig. 8. Wooden Patterns for a Pair of Heavy Cast-iron Dies

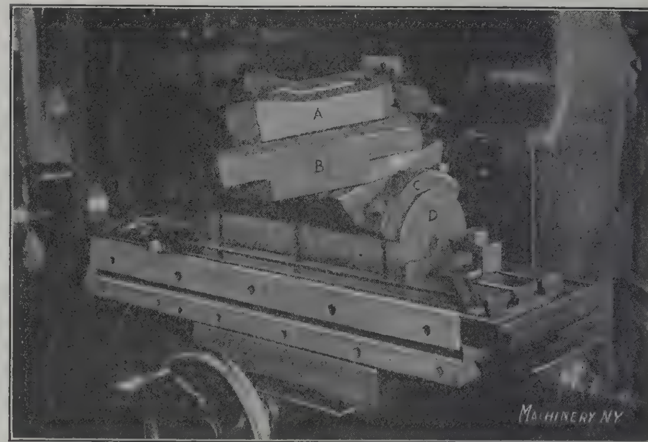


Fig. 9. Universal Angle-plate or Profiling Block used in Die Sinking

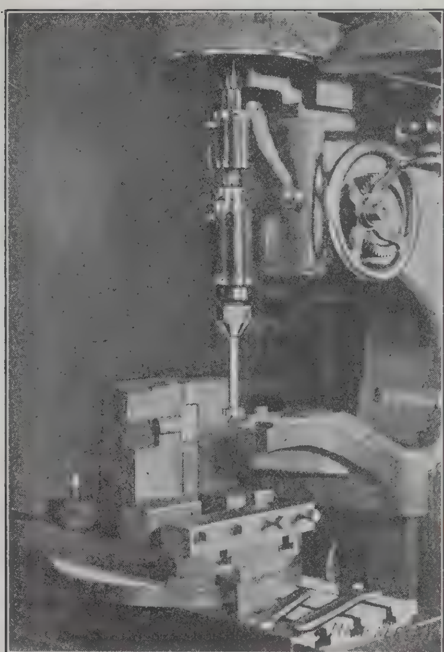


Fig. 10. Special Center Bracket used to Support Small Mill Arbors

Fig. 11. Dies in which a Boring Tool Shank is forged, and a Convenient Form of Shop Truck

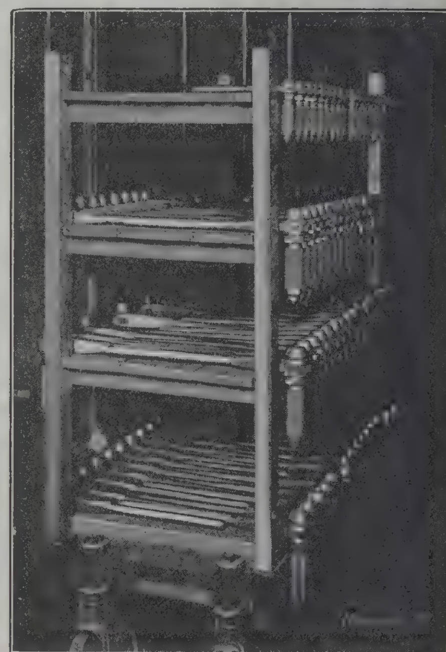


Fig. 12. Shop Truck with Shelves the Same Height as those in the Store-room

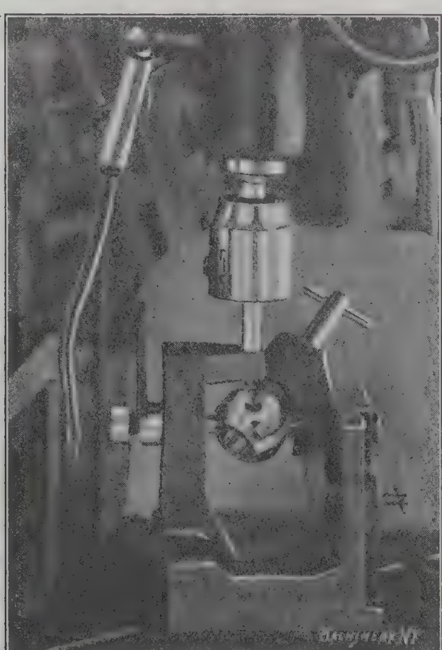


Fig. 13. Indexing Jig for Holding Hubs of Universal Ratchet Drills

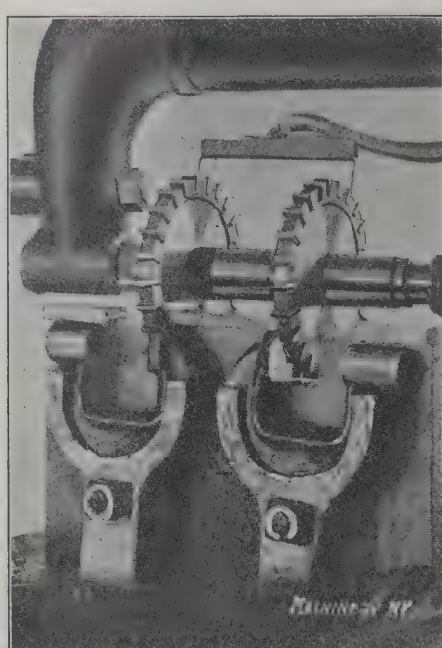


Fig. 14. Fixture which holds Two C-clamps while Faces are being milled

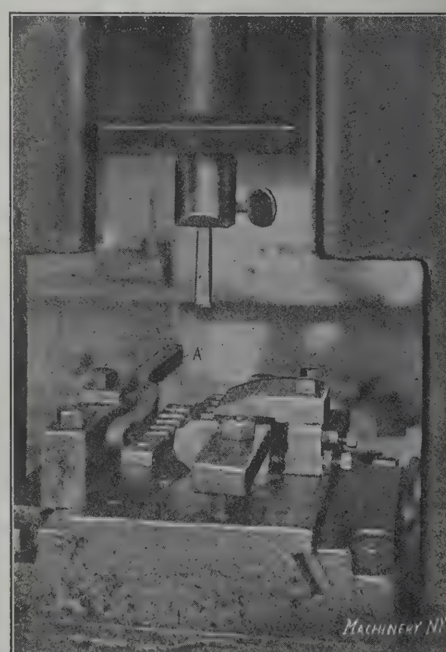


Fig. 15. The Way in which Planer Tool-holders of the Gang Type are broached in a Punch-press

The making of dies for the Armstrong boring tool, so that the metal would come out of the die, was quite a difficult problem. This was one of the few cases where getting the metal *into* the die was not the most important thing. It was easy enough to make a die that would forge up the shape required, but owing to the peculiar shape of the boring tool,

the metal would be wedged in too tight to be easily removed. This problem was worked out by using plaster of Paris in the way previously referred to, and the die as it was finally

Fig. 16. Drilling Set-screw Holes in the Gang Tool-holders


Fig. 17. Cutting High-speed Steel with rapidly-revolving Plain Tool Steel Disk

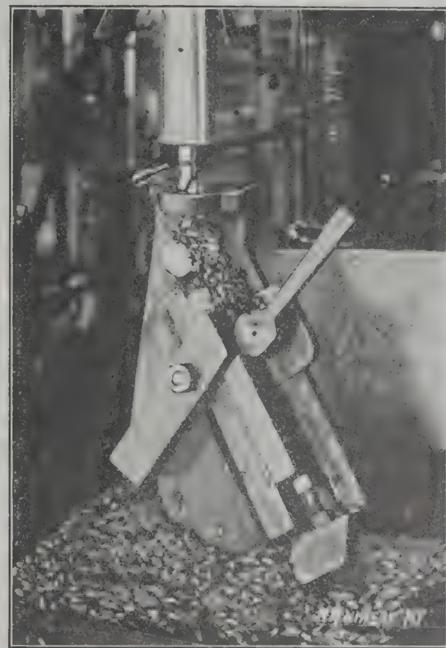


Fig. 18. Simple Form of Chuck for Drilling the Cutter Hole in Off-set Tool-holders

successfully made is shown in Fig. 11. One of the boring tool holders is shown lying on top of the die. The truck shown in this engraving is very useful, as it is just the

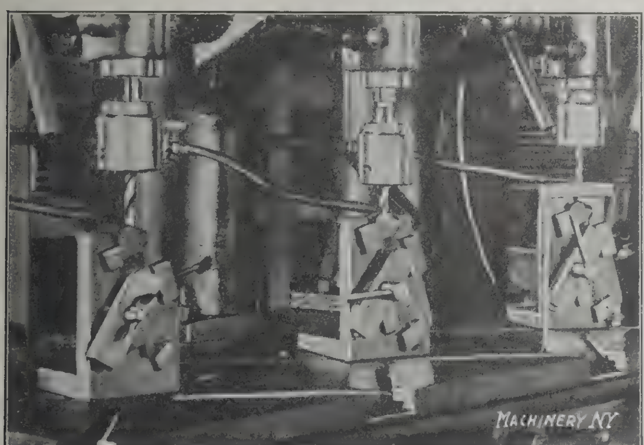


Fig. 19. Drilling the Cutter Holes in the Straight Lathe Tool-holder

height of the work benches and a heavy die can be easily pushed from one to the other. Another very handy truck used to carry finished tools from the assembling benches or shop to the storage shelves, is shown in Fig. 12. This truck is also used to carry tools packed in boxes to the shelves, and as the shelves of the truck are made the same height as the four lower shelves of the store-room, the boxes can be easily slipped into place.

Fig. 13 shows an indexing jig used to hold the hubs of the universal ratchet drills, the construction of which is too plainly shown to need explanation.

In Fig. 14 is shown the milling jig used to hold two C-clamps at once while machining the faces.

Gang planer tool-holders are broached out in a punch press as in Fig. 15. The fixture used to hold the gang tool-holder, is mounted on a slide which is fed under the broach one hole at a time, by lifting the dog-lever *A* and pushing the fixture along until the dog engages the next notch. The view shown was taken from the back of the press. The gang tool-holders are next placed in a very similar fixture, shown in Fig. 16, and the set-screw holes drilled.

Many employers and foremen complain about their men grinding away the tool-holder when sharpening the cutters; consequently a set of special holders has been made for customers, in which to place the steel while grinding. A set of these holders is shown in the rack on the grinder column in Fig. 17, and the man at the left is using one, holding it at the proper angle by pressing it down on the adjustable grinder rest. At the right in this engraving is shown a man cutting high-speed steel into suitable tool-holder lengths with a metal wheel. This wheel is 16 inches in diameter and runs at 2,500 revolutions per minute. It is simply a thin tool steel disk

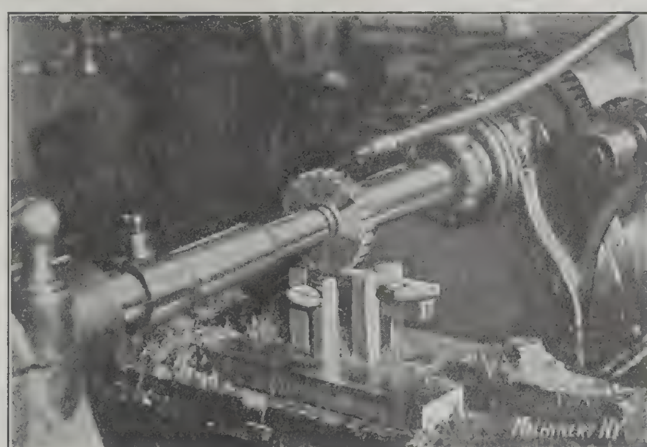


Fig. 20. Milling the Slots for the Blades in Cutting-off Tools

clamped between two big soft-steel washers. The steel bars are not cut off entirely but are just cut into slightly on the four sides and snapped off, the cuts on the sides being as

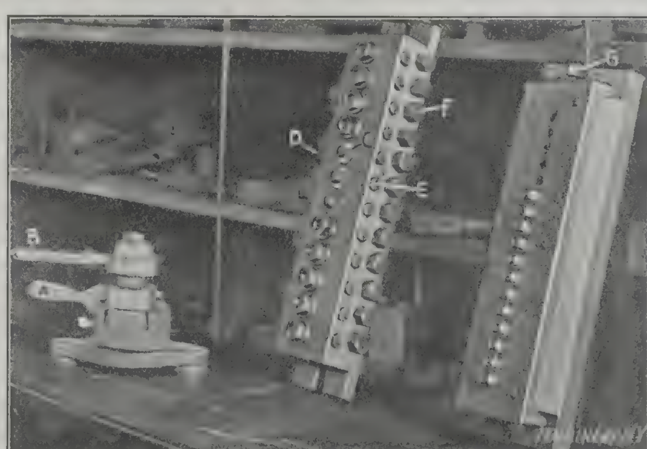


Fig. 21. Interesting Types of Fixtures for Holding Shoulder Nuts and Collar Head-screws, while they are being milled

clean as if made by a milling saw in soft metal. No teeth or anything of the kind are used on the cutting disk and the hard high-speed steel does not quickly wear the softer metal, as a "saw" lasts for a long time.

One of the simplest possible drilling jigs for holding offset tool-holders while drilling the cutter hole, is shown in Fig. 18, while in Fig. 19 is shown a set of three jigs used for the progressive drilling of the long cutter hole in the straight lathe tool-holder. After the cutter holes have been drilled as shown, they are broached out square in special turret broaching machines.

Slots for the blades of cutting-off tools are milled in the holder, as shown in Fig. 20. A close inspection of this jig will show that the tool-holder is pressed from below up against stops. This method makes all slots the same depth regardless of any slight difference in the thicknesses of the forgings. The pushing up of the clamping-block is done by a cap-screw underneath which is turned with an end wrench.

Three very interesting milling fixtures are shown in Fig. 21. The tool at the left is an indexing fixture for milling large hexagon shoulder-nuts, using either one or two mills at a time. The indexing is done by the lever *A*, the nut being held in the chuck which is operated by the lever *B*. The fixture in the center is for holding twelve shoulder-nuts while

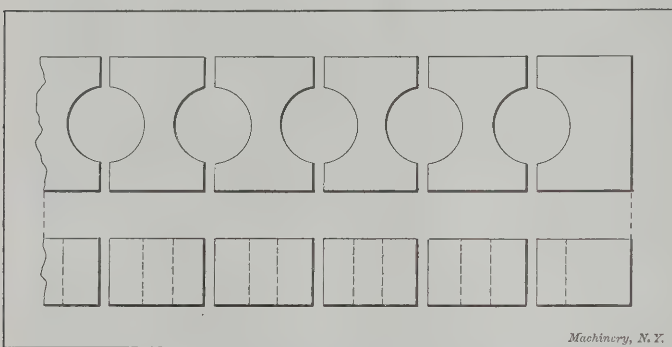


Fig. 22. Detail of the Clamping Blocks used in one of the Fixtures shown in Fig. 21

milling them hexagon, using straddle mills. The blanks are first faced and threaded and then screwed tightly down on the studs *C*, which are kept from turning by tightening the screws *D*. These screws are so arranged as to tighten two studs at a time. The nuts and screws *E* are simply lock nuts and pointed retaining screws, the ends of which fit into a groove turned in the stud shank. At *F* are the spring-actuated indexing stop-pins which are made to engage six notches in the stud shank, so that by simply loosening the lock screws *D* the nuts may be easily indexed with the fingers. Square-headed collar-screws are milled seventeen at a time, in the jig shown to the right. This jig is simple and easily operated. The screws to be milled are held by a series of clamping blocks, shown in detail in Fig. 22, which are set into a channel in the cast iron base of the jig, held in place by an iron top plate and tightened or loosened by the single set-screw *G*. No indexing device is used, but after the first straddle mill cut is taken the set-screw is loosened and the screws are turned a quarter way around by hand and lined up by using a gage with teeth in it like a big comb. The set-screw is again tightened and the final cut taken.

* * *

THE SMALLEST STEEL HAND STAMP

The engraving of the Lord's prayer on one side of a ten-cent piece and other feats of expert engravers even more remarkable have interested and astonished the public from time to time. The letters in these examples are of a microscopic size, and can be read only with the aid of a magnifying glass, but the difficulty of cutting them in copper or silver is small compared to cutting tool steel in relief, as is required for a stamping die. An interesting example of very small steel stamp work is now on exhibition at the New York store of William Dixon, Inc., 39 John St., which is said to be the smallest ever made. The die, which is of the common hand form hardened and tempered, stamps the name WILLIAM HOWARD TAFT in letters one two-hundredth (0.005) inch high, the seventeen letters making a line only 11/64 inch long. The name even when printed by the stamp on white paper with black ink cannot be read, without the aid of a magnifying glass, by any but the very sharpest eyes. The letters are all capitals, clean-cut and well-shaped. A page of MACHINERY on the same scale would be about ½ inch x 1 inch.

WATER REQUIRED TO COOL A GAS ENGINE

S. H. SWEET*

The water pump for a gas engine is generally designed to carry off one-half the heat produced by combustion. At times one-quarter would be sufficient but one-half is the amount that should be figured on. If the heat per minute generated by an engine is represented by q, then for a thermal efficiency of 12½ per cent, $q = 339.2 \times$ I. H. P., and $q \times 0.5 =$ the heat to be carried off by the water.

The constant 339.2 is obtained from the formula $q = \dfrac{\text{I. H. P.}}{E} \times \dfrac{33{,}000}{778}$. $E =$ the thermal efficiency, which for gasoline is taken as 12½ per cent. Hence, $q = \dfrac{\text{I. H. P.}}{0.125} \times \dfrac{33{,}000}{778} = 339.2 \times$ I. H. P. Other constants may be obtained by substituting the thermal efficiency expected or known. So far as I know the maximum efficiency of gasoline is 19 per cent, and a number of very good engines have shown about 15 per cent efficiency, but for the general run, the safe figure to use is 12½ per cent.

Let

$t - t_1 =$ allowable rise in temperature.

$t =$ maximum temperature of water in degrees F. (About 180 degrees should be the maximum temperature allowed.)

$t_1 =$ normal temperature of water in degrees F.

$W =$ the number of pounds of water required per minute,

then

$$W = \frac{169.6 \times \text{I.H.P.}}{t - t_1}$$

$t - t_1 =$ the number of B. T. U. absorbed per pound of water.

As the pump is generally attached to the engine shaft, it will have the same number of revolutions as the engine. Let p equal pounds of water required per revolution, then

TABLE GIVING PART OF A GALLON PER STROKE FOR VARIOUS SIZES OF SINGLE-ACTING PUMPS

Diam.	Area	Stroke						
		1	1½	2	3	4	5	6
½	0.196	0.0008	0.001	0.002	0.0025	0.003	0.004	0.005
⅝	0.307	0.001	0.002	0.003	0.004	0.005	0.007	0.008
¾	0.442	0.002	0.003	0.004	0.006	0.008	0.010	0.012
⅞	0.601	0.0025	0.004	0.005	0.008	0.010	0.013	0.016
1	0.785	0.003	0.005	0.007	0.011	0.014	0.017	0.020
1¼	1.227	0.005	0.007	0.010	0.016	0.021	0.026	0.032
1½	1.767	0.007	0.011	0.015	0.022	0.030	0.038	0.045
1¾	2.405	0.010	0.015	0.021	0.031	0.041	0.051	0.062
2	3.142	0.014	0.021	0.027	0.041	0.054	0.068	0.082

$$p = \frac{W}{\text{R. P. M.}}$$

As one gallon of water weighs 8.33 pounds,

$\dfrac{p}{8.33} =$ number of gallons required per revolution.

Let us take an example and assume that we wish to design a pump for a 20 I. H. P. gas engine which turns at 300 R. P. M.

$$q = 339.2 \times 20 = 6{,}784 \text{ B. T. U.}$$

$q \times 0.5 = 6{,}784 \times 0.5 = 3{,}392$ B. T. U., which is the amount of heat the water is to carry off.

$t = 180$, $t_1 = 60$, $180 - 60 = 120$.

$$W = \frac{169.6 \times 20}{120} = 28.267 \text{ pounds.}$$

$$p = \frac{28.267}{300} = 0.0942 \text{ pound per revolution.}$$

$$\frac{0.0942}{8.33} = 0.0113 \text{ gallon per revolution.}$$

By referring to the accompanying table we see that a pump 1½ inch bore by 1½ inch stroke will answer. The number

* Address: 190 Orchard St., Bridgeport, Conn.

of gallons pumped per minute is equal to the number of R. P. M. of a single acting pump multiplied by the number of gallons per revolution as given in the table.

[If the thermal efficiency of a gas engine were 100 per cent, that is if all the heat were converted into work, there would be no rejection of heat into the cylinder walls, and consequently no need for cooling water. Again, if the thermal efficiency were 50 per cent, one-half the heat would be rejected into the walls and exhaust while the other half was converted into work. The formula, therefore, is not strictly correct, as it does not take into consideration the percentage of heat converted into energy and which thus disappears.

Using the same notation, the formula should properly be:

$$q = \left(\frac{\text{I. H. P.}}{E} \times \frac{33{,}000}{778}\right) - \left(\frac{33{,}000 \times \text{I. H. P.}}{778}\right)$$

$$= \frac{(33{,}000 \text{ I.H.P.} \times 778) - (33{,}000 \text{ I.H.P.} \times 778\,E)}{778\,E \times 778}$$

$$= \frac{25{,}674{,}000 - 25{,}674{,}000\,E}{605{,}284\,E}$$

If $E = 12\frac{1}{2}$ per cent, then:

$$q = \frac{25{,}674{,}000 - 3{,}209{,}250}{75{,}660.5}$$

$$= 296.8$$

The thermal efficiency of gas engines being rarely more than 20 per cent the error in Mr. Sweet's method is not important and for practical purposes it is to be preferred because of its simplicity.—Editor.]

* * *

HOW BILLY CENTERED SHAFTS

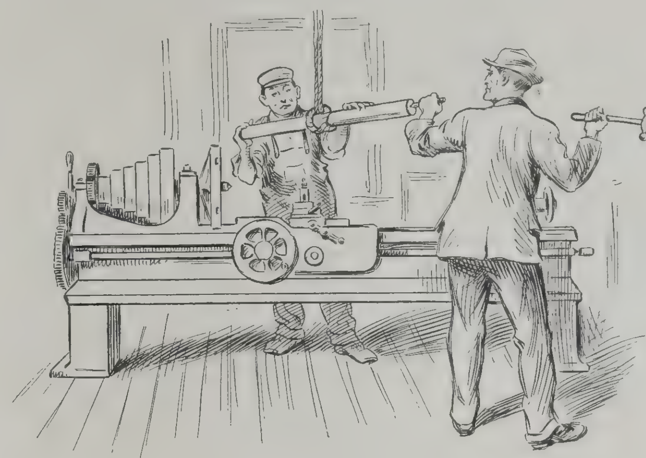
H. A. D.

Mr. William Collis, affectionately known amongst the boys as "Billy," was the foreman of the turning shop some twenty years or so ago. He was a working foreman too—not one of the kind who was afraid to dirty his hands—and to fill in his time between Monday morning and Saturday noon, when he was not giving out work or looking after his men he ran the shafting lathe—or rather the shafting lathe ran itself even when he was looking after the men, or when he was dozing on the top of his tool-chest, for in that shop there was no tool-room and each man kept his own special fancies in the way of tools, etc., under lock and key. High-speed steel was in the dim and distant future, and a cut over a shaft lasted a long time.

Now Billy's method of centering was as primitive as could be, the usual tools consisting of a center punch and hammer only. A square center was used sometimes, but this gave trouble in changing centers, putting something in the tool-post to press the shaft, and other little worries which could be avoided; therefore, by placing the center punch where he guessed the center of the shaft should be, and hitting it several good smart blows the thing was done—except, of course, when he had miscalculated as to the exact position of the center. It was then necessary to try the shaft in the lathe, and if too much eccentricity was found he would mark the "high side" with chalk, remove the shaft and "draw" the center by means of the punch, the shaft being swung in and out of the lathe by means of pulley blocks.

His assistant on the operation was generally one of the newer lads knocking around, and for the particular shaft in the story the services of Harry had been secured. Now Harry's sense of humor (?) was strongly developed, and he hated this particular job just as much as he was afraid of Billy, but his love of a joke overcame his fears one day, and here is the story:

Billy had made a particularly bad guess as to the position of the center of the shaft and had followed his usual practice up to the point of swinging the shaft out of the lathe, when he was called away to attend to some other duty. As Harry lolled around waiting for the work to proceed again, the little chalk mark persistently stared him in the face in such a manner that finally an idea struck him, that it would be funny if he rubbed it out and placed another on the *opposite side*. Of course, as in most things of importance, the main thing was to have the idea, the rest was easy and was soon accomplished. It was too good a joke to be enjoyed alone and several others soon knew what had been done, amongst them being one of Billy's own particular cronies. Billy returned soon afterwards, and resuming operations, drew the center towards the mark. His surprise was very pronounced when he saw the result of his latest efforts and the remarks he made about shafts in general and this one in particular are unprintable, but he fairly lost his temper when he caught sight of someone smiling, apparently at him.



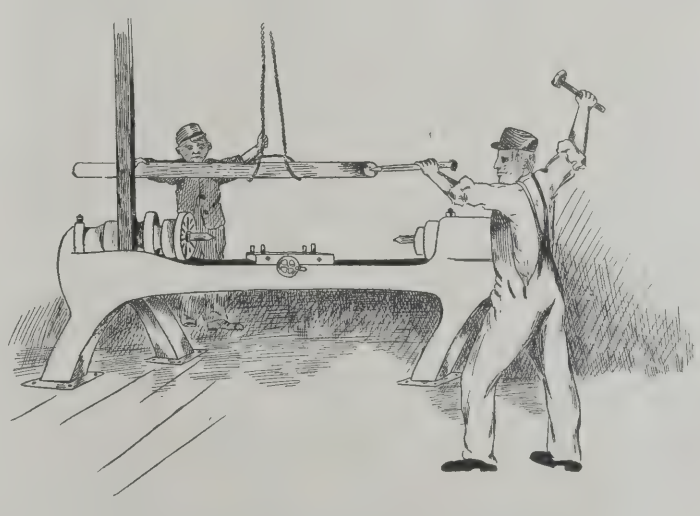
"Now Billy's method of centering shafts was primitive"

Poor Harry wanted to laugh, too, but dared not, so offered what consolation he thought would meet the case, suggesting that Billy had perhaps made a mistake, and should have drawn the center *away* from the mark, but Billy said he might do that when he started his second apprenticeship and knew no better. From his manner towards his assistant the next day it was clear he had learned over night what had occurred, but he was not vindictive, and afterward enjoyed the joke as much as anyone.

* * *

HOW BILLY DIDN'T CENTER SHAFTS

This startling sketch illustrates an amateur artist's weird conception of a shafting lathe and a machinist's way of handling centering tools. He was asked to make a drawing for "How Billy Centered Shafts," and the result exceeded our wildest expectations. We are impressed particularly with the lathe legs. How well they don't harmonize with modern



"Our regret is that we don't know the tool-smith who forged that center-punch and the concern that made the hammer"

ideas of machine design; they appear to us to belong to the bulldog type of architecture! Note the "patent" head-stock and the "unpatent" foot-stock, and the doleful expression of the cub, who can't for his life see how to swing an eight-foot shaft between five-foot centers. The carriage is a gem—but why proceed further? The makers are unknown and we don't care. Our regret is that we don't know the toolsmith who forged that center-punch and the concern that made the hammer.

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DECEMBER, 1909

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

CHINESE METHODS IN DESIGN

One of the most delightful of Charles Lamb's "Essays of Elia," deals with the alleged discovery of roast pig by the Chinese. As the story goes, a Chinaman's house was burned up and his pig lost in the flames. While poking around in the ruins the Chinaman came upon the body of the unfortunate beast, and in the handling found it necessary to cool his fingers, which he did by putting them in his mouth, when he tasted for the first time in the history of mankind the sweet and delicate flavor of roast pig. The narrative goes on to state that for some time thereafter Chinamen's houses were burned down regularly and frequently, and roasted pigs were always found in the ruins, until an inspired genius discovered a shorter and less expensive method of producing the same result.

It sometimes seems as though there are very few machine designers who have gotten out of what may be called the "house burning stage" in machine design. Why is it that nine times out of ten the first design of a new machine is too light, the second design a little heavier, the next heavier still; and only in the course of years is the tool designed so as to be strong enough for its work? Instead of wasting time and money all around in repeated strengthening, why not make the machine strong enough in the first place—or even too strong? It would be a welcome change to see a machine pared down a little in weight in successive developments, instead of having it corrected repeatedly in the opposite direction.

* * *

ELECTRIC DRIVE IN THE MACHINE SHOP

When electric drive was first being introduced into machine shops and factory equipment, claims were made for the power saved by elimination of line-shaft and belt losses, and the more important but not obvious economies were not pointed out, either because of ignorance or lack of appreciation. In the machine shop the greatest advantage of electric drive doubtless lies in the increase of product made possible by constantly adjusting the speed of the work to the full capacity of the cutter and thus working the machine always at its maximum rating, pre-supposing that variable speed motors are used to drive the machines. In a paper on the economy of electric drive in machine shops, to be presented before the A. S. M. E. in December, Mr. De Leeuw lays stress on this element of advantage, it being of much greater importance than the mere saving of power. In fact we may conclude that if it were simply a matter of saving power it is doubtful if it would pay in many cases to make the change from line-shaft drive to motor drive.

To illustrate, the conditions in a shop are quoted where an average of nine tons of metal is machined daily. The metal is, for the greater part, cast iron with a small percentage of steel, bronze and other metals. The chips removed amount to about 2,700 pounds of metal in a nine-hour day, making 300 pounds per hour or five pounds per minute. The power required is about 225 H.P. which, with a production of 5 pounds of chips per minute means that 45 H.P. per minute for each pound of chips removed is consumed. The power costs about $40 per H.P. per year or $9,000 per year including the steam for heating the building. Now, if one-half the amount spent for power could be saved by another mode of drive, the total possible gain would be only $4,500 per year. The shop employs about 500 men, and the gain per man would be $9 per year. The yearly product per man is about $2,000 from which it becomes evident that the small gain of 5 per cent in productive capacity would be much greater than the saving in power, and this is a large consideration in the economy of electric drive in the machine shop.

The importance of increasing the product by the substitution of electric drive for line-shafts and belts is greatest in the matter of capital investment when a plant is working practically to its limit, and any increase of capacity in the direction of new building and new machinery means perhaps a prohibitive cost, to say nothing of the delay in getting the equipment into shape. The substitution of electric drive to increase the capacity may make an increase in the number of machines unnecessary, and thus save making a large investment, much greater than the cost of the change. There are other advantages than those of electric drive that may be enumerated, but the increase in efficiency of machine and man made possible by the variable speed motor is the chief consideration for the machine shop manager.

* * *

STRESSES IN CURVED MACHINE MEMBERS

The A. S. M. E. paper on stresses in curved machine members, abstracted in another part of this number, engineering edition, is a valuable contribution to the society's proceedings, being one that can be studied with profit by designers of hooks, punch and shear frames, C-frame riveters and other similar structures in which the loads induce combined tensile and bending stress. The familiar formula $f_c = \frac{W}{A} + \frac{Wle}{I}$ found in text-books on machine design is based on the assumption that curved machine members under load act as do beams originally straight, but this supposition has been known for some time to be erroneous, the calculated factor of safety being much more than that known to actually exist. The results of tests on hooks of cast steel and wrought iron at Columbia University show conclusively that the old formula is very seriously at fault, the actual load at the elastic limit being, roughly, one-half, or less, of the calculated load.

So serious a discrepancy between the results of calculations and actual tests, and on the wrong side at that, cannot be tolerated. Future treatment of the subject in works on machine design must take into account the newer theory from which Andrews and Pearson have deduced a formula that appears to agree well with the results of tests. In fact, there is a surprisingly close agreement of the test loads and the calculated loads in the Columbia experiments when figured by this formula. Unfortunately it is not readily handled by a designer unfamiliar with higher analysis, but by the use of constants that have been derived for the common hook section, the use of the resulting modified expression is made comparatively easy.

It is cases like this that have given cause for the not uncommon belief that theory and practice do not agree, and it is not strange that the hard-headed practical man has some contempt for the purely theoretical designer, when machine members fail with no apparent reason in theory. But, theory and practice will agree when the theory takes into consideration all the factors affecting the problem and the mathematical formulas are correctly deduced. Effort to fit a fact to an untenable theory must necessarily fail, and when it fails, as in this case, in producing results that are tolerable, we must change the theory to fit the fact.

* * *

TURBINE PUMP MOTOR DRIVE

The turbine pump has come to be recognized as a practical pumping machine peculiarly well suited to certain conditions, the same as the steam turbine prime mover. It has been used for pumping against very high heads with success, but notwithstanding its essential simplicity, some peculiar problems have been met in its design and construction that have baffled the designers. One of these problems concerns the matter of drive. When a turbine pump is driven by an electric motor, the motor conditions become very bad if the head fluctuates. There is great danger of over-loading the motor with a low head, strange as it may seem at first thought. The natural inference is that with a low head the load would become less than with a high head, but the contrary is the case. A turbine pump designed to deliver a certain quantity of water against a head, say, of 100 feet will operate smoothly when driven by an electric motor so long as the water approximates the given head, but should the head fall to 75 or 50 feet, the chances are that the motor would be over-loaded. A larger quantity of water than normal is pumped at lower efficiency, the work done increasing rapidly with decrease of head.

The reason for this action is that the turbine pump operates under conditions analogous to those affecting the electric generator. A generator carries its normal load so long as the resistance in its circuit is that for which it is designed. But, should a short circuit or reduction of resistance through other means occur, the generator at once becomes over-loaded, and will break down or burn out if continued in operation. In the case of a turbine pump, the head corresponds to the ohmic resistance and the quantity of water pumped to the amperes of current. When the head under which a motor-driven turbine pump is working decreases, the pressure or resistance is decreased and the quantity of water handled is increased, the consequence being that the pump is over-loaded while working at a low efficiency, the same as the generator. The over-load must be carried by the motor and unless the motor has good over-load capacity it will not stand up under the service. However, the characteristics of the best turbine pumps have been improved so that considerable fluctuation of head will not greatly increase the load or decrease the pump efficiency.

* * *

GASOLINE AND ALCOHOL MOTORS COMPARED

The United States Geological Survey, has just issued a bulletin on "Commercial Deductions from Comparisons of Gasoline and Alcohol Tests on Internal-Combustion Engines," by Robert M. Strong. The tests, which were under the technical direction of R. H. Fernald, engineer in charge of the producer-gas section of the technologic branch, were conducted at the fuel-testing plant in St. Louis, Mo., and at Norfolk, Va. The tests dealt primarily with gasoline, forming part of the investigation of mineral fuels provided for by acts of Congress. To determine the relative economy and efficiency of gasoline it was compared with denatured alcohol. When the series of tests was started, it was found that it took from one and one-half to two times as much alcohol as gasoline to produce a given power. With special alcohol engines, entirely suited to the use of alcohol, the latter fuel has been made to do as much work, gallon for gallon, as the gasoline.

By using alcohol in an alcohol engine with a high degree of compression (about 180 pounds per square inch above atmospheric pressure—much higher than can be used for gasoline on account of pre-ignition from the high temperatures produced by compression) the fuel consumption rate in gallons per horse-power per hour can be reduced to practically the same as the rate of consumption of gasoline for a gasoline engine of the same size and speed. The indications are that this possible 1-to-1 fuel consumption, ratio by volume, for gasoline and alcohol engines, will hold true for any size or speed, if the cylinder dimensions and revolutions per minute of the two engines are the same.

The low heating value of completely denatured alcohol will average 10,500 British thermal units per pound, or 71,900 British thermal units per gallon. The low heating value of 0.71 to 0.73 specific gravity gasoline will average 19,200 British thermal units per pound, or 115,800 British thermal units per gallon. Thus the low heating value of a pound of alcohol is approximately six-tenths of the low heating value of a pound of gasoline. A pound of gasoline requires about twice the weight of air for complete combustion as a pound of alcohol.

A gasoline engine having a compression pressure of 70 pounds but otherwise as well suited to the economical use of denatured alcohol as gasoline, will, when using alcohol, have an available horse-power about ten per cent greater than when using gasoline. When the fuels for which they are designed are used to an equal advantage, the maximum available horse-power of an alcohol engine having a compression pressure of 180 pounds is about 30 per cent greater than that of a gasoline engine having a compression pressure of 70 pounds, but of the same size in respect to cylinder diameter, stroke and speed.

Alcohol diluted with water in any proportion, from denatured alcohol which contains about 10 per cent of water, to mixtures containing about as much water as denatured alcohol, can be used in gasoline and alcohol engines if they are properly equipped and adjusted.

When used in an engine having a constant degree of compression, the amount of pure alcohol required for any given load increases and the maximum available horse-power of the engine decreases with a diminution in the percentage of pure alcohol in the diluted alcohol supplied. The rate of increase and decrease respectively is such, however, that the use of 80 per cent alcohol instead of 90 per cent, or denatured alcohol, has but little effect upon the performance of the engine; so that if 80 per cent alcohol can be had for 15 per cent less cost than 90 per cent alcohol and could be sold without tax when denatured, it would be more economical to use the 80 per cent alcohol.

The relative hazard involved in the storage and handling of gasoline and denatured alcohol is of particular importance in considering their use as fuels for marine and factory engines and engines to be placed in the basements of office buildings, in coast defense fortifications, or in like places where a general fire would be likely to result from the accidental burning of the fuel stored or carried for immediate supply, or where the forming of explosive or inflammable mixtures of the fuel vapors and air in the immediate vicinity would be hazardous. It is indicated by statistics and is also the general consensus of opinion of those experienced in handling gasoline, kerosene, and alcohol that the hazard involved in the use of denatured alcohol is very much less than in the use of gasoline and possibly less than in the use of kerosene, but as yet the relative fire risk has not been definitely established. Considerable work has been done on this phase of the investigation and a series of tests that will be of assistance in determining the relative hazard involved in the use of these fuels is in progress at the testing station of the Survey in Pittsburg.

In regard to general cleanliness, such as absence of smoke and disagreeable odors, alcohol has many advantages over gasoline or kerosene as a fuel. The exhaust from an alcohol engine is never clouded with a black or grayish smoke, as is the exhaust of a gasoline or kerosene engine when the combustion of the fuel is incomplete, and, it is seldom, if ever, clouded with a bluish smoke when a cylinder oil of too low a fire test is used or an excessive amount supplied, as is so often the case with a gasoline engine. The odors of denatured alcohol and the exhaust gases from an alcohol engine are also not likely to be as obnoxious as the odor of gasoline and its products of combustion.

Very few alcohol engines are being used in the United States at the present time, and but little has been done toward mak-

ing them as adaptable as gasoline engines to the requirements of the various classes of service. Engines for stationary, marine, and traction service, automobiles, motor trucks, and motor railway cars designed especially to use denatured alcohol have, however, been tried with considerable success.

The price of denatured alcohol is greater than the price of gasoline, and the quantity of denatured alcohol consumed by an alcohol engine as ordinarily constructed and operated is, in general, relatively greater than the quantity of gasoline consumed by a gasoline engine of the same type. Considerable attention is being given to the development of processes for the manufacture of alcohol from cheap raw materials which are generally available, and it seems reasonable to expect that the price of denatured alcohol will eventually become as low or lower than the price of gasoline, especially if the price of gasoline advances. It also seems reasonable to expect a greater general improvement in alcohol engines than in gasoline engines.

When used as a fuel, denatured alcohol is not always so classed as to be exempt from restrictions placed on the use of gasoline by the rules of insurance and transportation companies or city ordinances. The restrictions that are placed on the use of denatured alcohol are, however, never greater than those placed on the use of gasoline. In some places, they are such that the use of an alcohol engine is permitted where the use of a gasoline engine is prohibited. For instance, alcohol motor trucks and automobiles are admitted to many steamer piers that are not open to gasoline machines.

When the restrictions placed upon the use of denatured alcohol are less than those placed on the use of gasoline or where safety and cleanliness are important requisites, the advantages to be gained by the use of alcohol engines in place of gasoline engines may be such as to overbalance a considerable increase in fuel expense, especially if the cost of a fuel is but a small portion of the total expense involved, as is often the case. Denatured alcohol will, however, probably not be used for power purposes to any great extent until its price and the price of gasoline become equal and the equality of gasoline and alcohol engines in respect to ability to service required and quantity of fuel consumed per brake horse-power, which has been demonstrated to be possible, becomes more generally realized.

A further general development in the design and construction of engines that use kerosene, or cheaper distillates, and the crude petroleums may be reasonably expected and may delay the extensive use of denatured alcohol for some time to come, but as yet comparatively few data pertaining to this phase of the general investigation are available.

* * *

AUTOMOBILE SPRINGS

The development of the automobile has proved that the ordinary carriage spring is inadequate to meet the severe requirements of automobile service. Manufacturers have experimented with many grades of foreign and domestic steels including chrome-nickel, tungsten, vanadium and other special alloys with results more or less satisfactory depending largely on the heat treatment. The experience of some makers, members of the A. L. A. M., appears to indicate that silico-manganese springs endure longer than high carbon steel, but whatever steel is used, it must be made to certain specified analyses and heat treated in an approved manner to yield satisfaction. It is necessary to have the furnaces under pyrometer control, and so closely regulated that there is but very slight variation in temperature. The most commonly used heat treatments are annealing, hardening, tempering, hardening and annealing, double annealing, and double hardening. A long flat spring is preferable to a spring with considerable arch as the fiber stress is lower for the same load and deflection. The deflection should not be more than one-fourth inch per hundred pounds. The reason leaf springs are preferable to coil springs is the greater dampening effect of the leaf springs, because of the friction between the component parts of the spring. A leaf spring does not return to its normal position so quickly and forcibly as a coil spring of the same capacity, hence its easier effect upon the car and its occupants.

THE DESIGN OF CURVED MACHINE MEMBERS UNDER ECCENTRIC LOAD*

Machine members, such as frames for punches, shears and riveters, hooks and the like, when subjected to load, are generally supposed to behave like beams originally straight and subjected to the same conditions. The usual analysis applied to such beams in determining the proportions required to withstand safely a given stress assumes that the maximum tensile stress equals the load considered as uniformly distributed over the section plus the stress due to the eccentricity of the load. Symbolically expressed

$$f_t = \frac{W}{A} + \frac{Wle}{I}$$

f_t = maximum intensity of tensile stress,
W = load on beam,
A = area of section,

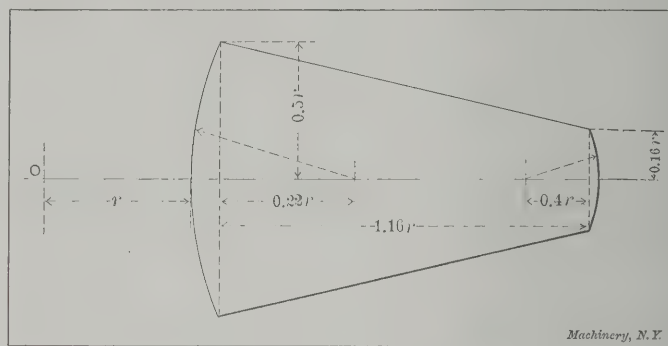

Fig. 1. Section of Crane Hook

l = eccentricity of loading,
e = distance from gravity axis of section to point under stress f_t
I = moment of inertia.

This analysis is unfortunately prevalent in textbooks on the design of machine elements and strength of materials, and has been accepted generally because of long standing. However, it does not agree with the results of experiment on members of this kind; in fact such experimental results are so different from results calculated by this formula that no confidence whatever can be placed in it, and safe proportions can be obtained only by the use of a large factor of safety.

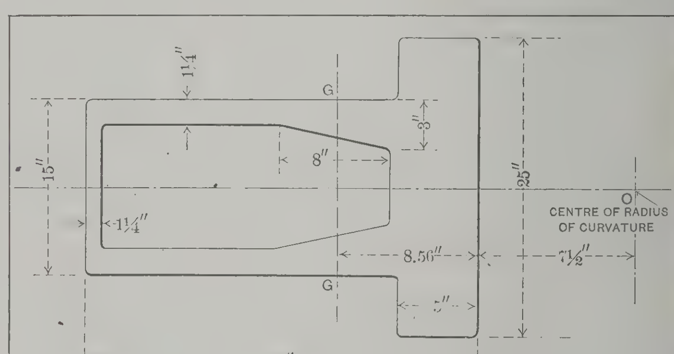

Fig. 2. Section of Punch and Riveter Frame

The results of a series of experiments which are remarkable in their disagreement with the results obtained by the formula are given in the accompanying table. The crane hook was taken as an example of a beam of this sort and experiments were conducted on ten hooks ranging from two to thirty tons rated capacity.

It is very evident that the assumptions on which the conventional formula is based are not correct, and that machine members designed on this basis have a much smaller factor of safety than is generally supposed. While this has been known in some quarters and attempts have been made to bring about an adjustment, no theory which has been developed seems to fit the case better than that evolved by E. S. Andrews and

* Abstract of paper by Prof. Walter Rautenstrauch, read before the November, 1909, meeting of the American Society of Mechanical Engineers.

Prof. Karl Pearson of London University. Their investigation gives the following expression for the tensile stress at the most strained point in the principal section of beam:

$$f_t = \frac{W}{A}\left\{\frac{l}{\rho\gamma_2}\left(\frac{1}{\left(1-\frac{e}{\rho}\right)^{\frac{5}{4}}} - \gamma_1\right) + 1\right\}$$

f_t = tensile stress at most strained point of section, pounds per square inch,
W = load on hook, pounds,
A = area of section, square inches,
l = distance from load line to gravity axis of section,
ρ = radius of curvature of belly of hook at gravity axis,
e = distance from gravity axis to point of maximum tensile stress,
γ_1 and γ_2 are functions the values of which are determined for each section by means of rather complicated higher analysis; approximate values are given in the following.

This formula was applied to each of the hooks tested, with the results recorded in the third line of the accompanying table. An inspection of this table will show how nearly the analysis of Mr. Andrews and Professor Pearson fits the case.

In its present form it is a rather unwieldy instrument in the hands of a designer, but it may be made more applicable to design than might be thought at first. The functions γ_1 and γ_2 are constants for all sections of similar form, that is, for all sections the proportions of which may be expressed as a function of some unit of dimension, for example, the radius of curvature. Under the same circumstances the entire expression within the brackets is a constant. The equation for a series of sizes and sections may therefore be written $f_t = \frac{W}{A}K$, or $A = \frac{W}{f_t}K$. The area is a function of the unit squared and therefore we may write $A = C'r^2$, or

$$r = \sqrt{\frac{K}{C'} \times \frac{W}{f_t}} = C\sqrt{\frac{W}{f_t}}$$

Applying this to the case of a series of hooks ranging from the minimum to the maximum to be manufactured, a standard form of section may be laid out as in Fig. 1, and the constant established. For the hooks tested by the writer the following values for the constant were found:

30-ton hook, cast steel....................	3.00
30-ton hook, cast steel....................	3.10
15-ton hook, cast steel....................	3.23
15-ton hook, wrought iron..................	4.29
10-ton hook, cast steel....................	3.49
10-ton hook, wrought iron..................	3.42
5-ton hook, cast steel....................	3.12
5-ton hook, wrought iron..................	3.12
3-ton hook, cast steel....................	3.78
2-ton hook, cast steel....................	3.74
Average	3.43

To make the case representative of present practice let such ratio of proportions be assigned to the section shown in Fig. 1 that $C = 3.4$. The design of a series of wrought iron hooks to sustain loads of from 2 to 40 tons with a limiting intensity of tensile stress of 30,000 pounds per square inch will require the following computations:

$$\text{40-ton hook, } r = 3.4\sqrt{\frac{80000}{30000}} = 5.54$$

$$\text{30-ton hook, } r = 3.4\sqrt{\frac{60000}{30000}} = 4.7$$

$$\text{20-ton hook, } r = 3.4\sqrt{\frac{40000}{30000}} = 3.94$$

$$\text{10-ton hook, } r = 3.4\sqrt{\frac{20000}{30000}} = 2.76$$

$$\text{5-ton hook, } r = 3.4\sqrt{\frac{10000}{30000}} = 1.95$$

$$\text{2-ton hook, } r = 3.4\sqrt{\frac{4000}{30000}} = 1.23$$

The proportions obtained above will be for loads giving a maximum stress at the elastic limit of the material. For cast steel different values will necessarily be obtained. The establishment of such a standard would lead to a very simple process for the determination of the principal section of a hook for any capacity; the proportions of the shank and other parts of the hook may readily be established on the same basis. The bottom of the hook, being subjected to much wear, cannot of course be proportioned on the basis of the stress analysis. The above standard section selected as an average representative of present practice is not, however, the most economic form of section from the standpoint of equal maximum tensile and compressive stresses. It has been pointed out by Professor Pearson that a section with such proportions is approximately an isosceles triangle with a radius of curvature of 1.75 of the height. The more nearly this form could be approached, the less would be the weight of hook.

ANALYSIS OF HOOKS TESTED

Load at Elastic Limit, Pounds

Rated Capacity	30-ton Cast Steel	20-ton Cast Steel	15-ton		10-ton		5-ton		3-ton	2-ton
			Cast Steel	Wrought Iron	Cast Steel	Wrought Iron	Cast Steel	Wrought Iron	Cast Steel	Cast Steel
By test..............	56,000	30,000	48,000	16,000	18,000	16,000	18,000	14,000	8,500	4,700
By standard formula.	115,000	70,000	145,000	73,000	43,000	26,000	52,300	20,800	14,900	14,900
By new formula......	55,080	29,925	50,570	15,000	16,500	15,000	18,950	14;100	8,600	4,400

Professor Goodman points out that for hook sections the functions γ_1 and γ_2 are expressed approximately as follows:

$$\gamma_2 = \frac{ke}{1.2\,\rho^2}$$

$$\gamma_1 = 1 + 1.1\,\gamma_2$$

where k = radius of gyration of the sections, the other symbols being as before noted.

In applying these empirical formulas to punch and riveter frame sections the writer has found that the results are not accurate, but that the values are better expressed as follows:

$$\gamma_2 = \frac{ke}{0.7\,\rho^2}$$

$$\gamma_1 = 1 + 1.1\,\gamma_2$$

For example, consider the design for a punch frame shown in Fig. 2. Computing the values for the functions γ_1 and γ_2 by the empirical formula, $\gamma_1 = 1.44$, $\gamma_2 = 0.4$. Whereupon the intensity of stress according to the new method of analysis for a force of 90,000 pounds at the punch will be

$$f_t = \frac{W}{A}\left\{\frac{l}{\rho\gamma_2}\left(\frac{1}{\left(1-\frac{e}{\rho}\right)^{\frac{5}{4}}} - \gamma_1\right) + 1\right\} = 8500 \text{ pounds per square inch, approximately}$$

According to the old formula used almost exclusively in text books, the value of f_t is expressed by $\frac{W}{A} + \frac{Wle}{I}$, whence $f_t = 2{,}450$. It may be clearly seen that were the punch in question designed for a limiting intensity of stress of 2,450 by the old formula, there would actually be a maximum stress of 8,500 pounds per square inch, which is hardly a safe value for cast iron and particularly for a large casting.

The above empirical formulas are derived from the results of computation of two sections and may not work out as correctly in all cases.

ASSEMBLING A 48-INCH MOTOR-DRIVEN PLANER*—1

ALFRED SPANGENBERG†

In planer erection, the principal points to be observed are that the housings must be parallel with each other and square with the bed; accuracy is essential in the fit of all sliding members and in the truth of all plane bearing surfaces; the gears should mesh properly and run smoothly; and the system must be such as to permit the various parts to be easily and quickly assembled, and avoid the necessity of fitting the members together for the laying-out operations. This, of course, presupposes the employment of jigs and gages, but, owing to the fact that planers of the 48-inch size and upwards are seldom built in large numbers at a time, and further, that there are many different types of drive, it is impracticable to indulge very freely in the use of elaborate jigs for duplicating the larger parts. However, many of the members used in the construction of planers are common to several different sizes and different types of drive, so that with a few very simple jigs and gages, the standard members can be made interchangeable, and in this way much expensive handling in laying out, and the consequent lost time, is avoided.

This article will deal principally with the erecting process on the bed, since the methods and processes employed in assembling the smaller units do not differ greatly from the practice used in assembling those of other machine tools. All the principles involved in the erection of a small planer are encountered in the case of a large machine, and many other complicating factors are added; hence, the erection a planer of the latter class will be described in detail. For this purpose a 48-inch motor-driven planer is selected, the general features of which are immediately apparent from a study of the half-tone Fig. 1.

As the machining processes are so intimately correlated with those of assembling, and as the methods employed in the latter are controlled to a great extent by the former, a brief description of the points to be observed in machining, together with the gages used for testing the larger members, will be illustrated and described. Referring to Fig. 2, A indicates a gage for testing the V-surfaces on both the bed and table, it being shown in position on the latter. The surfaces B, which support the gage, are finished first, and in this way the gage is always kept in a horizontal plane and both tracks are the same width, so that when the table is placed in position on the bed, the top of the table will be square with the housings. Another advantage of this gage over the usual form having a bearing on both sides of the V, is that only two parallel surfaces are finished and tested at a time, which often saves changing the planing tools and resetting the toolheads. The gage is squared by trying a 0.001-inch feeler on both sides of the gage as at C and C_1. To determine the width of the V tracks on the bed and table, measurements are taken at D and D_1, respectively.

The gage just described is not adapted for measuring the rack seat, however, and therefore another gage is provided which fits both sides of the V's, and is represented by the dotted lines. This gage carries a slide E which measures the rack seat. At F is shown a sheet iron support which fits either gage and prevents it from tipping over.

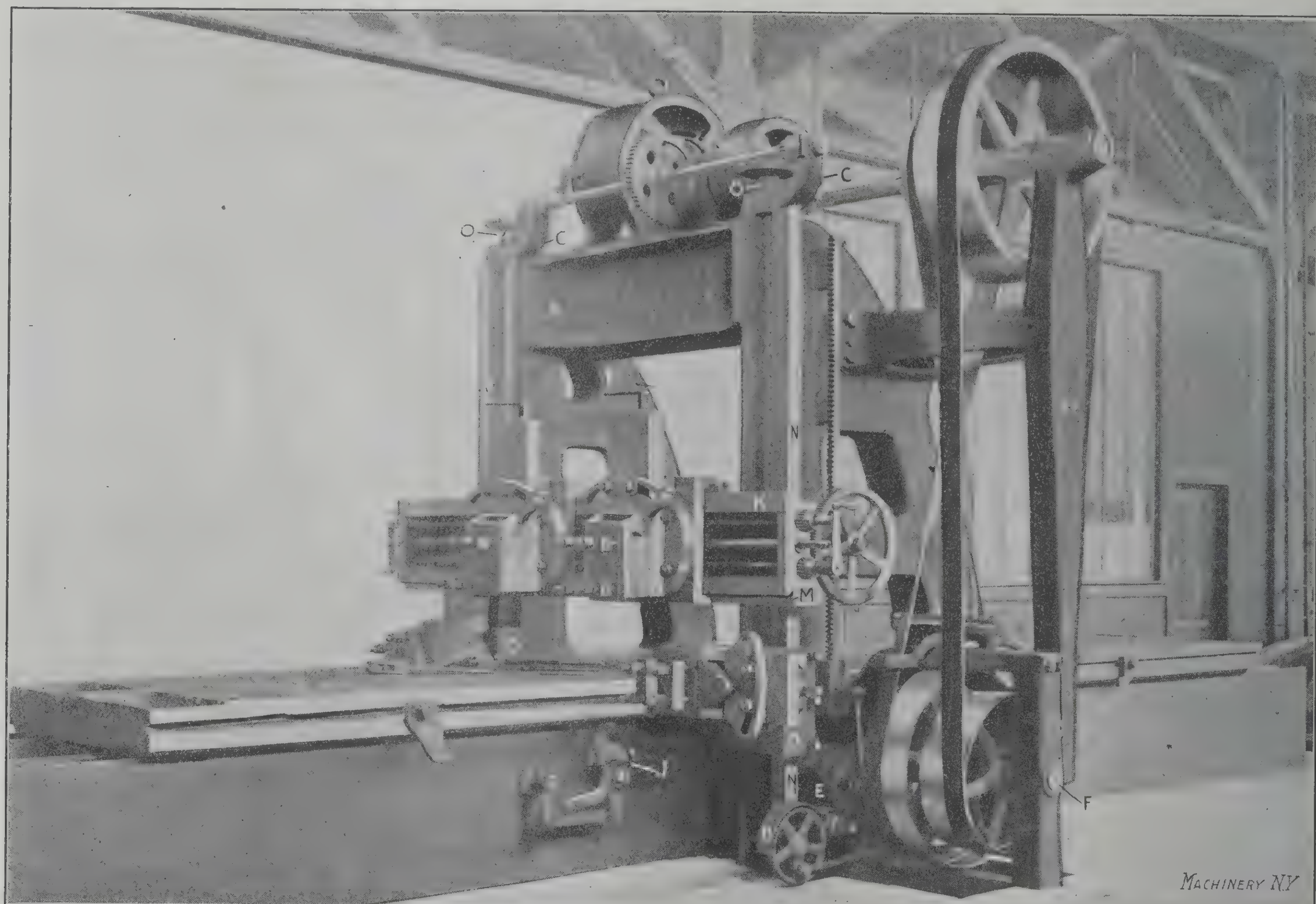

Fig. 1. Forty-eight-inch Motor-driven Planer, used as Example for Illustrating Principles Involved in Assembling Planers

In the same illustration, at G, is shown the method of testing the table on surfaces H and H_1, which have a clearance of 0.005 inch between corresponding surfaces on the bed. As will be seen, the cast iron gage block I fits the V on the table and is provided with two surfaces, one, J, for setting the planer tool, and another, K, for testing surface H after the finishing cut is taken. To the right, at L, is shown another cast iron gage, this being used for setting the tools and testing the surfaces M and N; at L_1 the gage is shown in position in the V track of the bed. As will be pointed out later, the object of finishing the surface N last is to provide a locating surface for the jig for boring the bed. In this way, the rack gear shaft hole is bored the correct distance from the V tracks, so that when the table is in position, the table rack will mesh properly with its gears. Length gages O, P, Q, and R are for testing the measurements indicated, the latter also

* For additional information on this and kindred subjects, see "Assembling a 24-inch Engine Lathe," in the November, 1909, issue of MACHINERY, and articles there referred to.

† Address: 951 W. 5th St., Plainfield, N. J.

being used for taking the length of the arch *A*, Fig. 1.

It is essential, of course, that the housing cheeks on the bed be perfectly square with the V-tracks and parallel with each other. To accomplish this, the sweep *S*, carrying the Starrett indicator *T*, is used in connection with the straight-edge *U*, which reaches across the bed and extends a sufficient amount beyond one side to accommodate the swing of the indicator. By this means very accurate results are obtained. The operator holds the bar *V* in contact with the bed, and the flanged bearing *W*, being of ample diameter and ground true with the bar, keeps the bar in a vertical plane.

Boring and Drilling the Bed

The bed, having passed inspection with regard to the accuracy of the planing operations, is now sent to the horizontal boring and drilling machine where all the boring, drilling, and tapping operations are completed; one setting only is required, as the machine is provided with two separate columns carrying spindle heads, both working on each side of the bed simultaneously. In the line-engraving Fig. 3 the bed is seen resting on parallels *A* with the jig *B* in position ready for the operations just mentioned. As will be observed from the top view, the jig consists of three main castings *C*, *D*, and *E*, respectively, which are bolted to the three cast iron tie bars *F*; this construction permits adjustment of members *D* and *E* to compensate for beds having different widths over the housing cheeks. The jig rests on the top of the bed, and is located endwise with reference to the jig members *D* and *E* matching the bed casting, so that when the housings, which have been drilled by a separate jig, are bolted onto the bed, the castings will match properly. Set-screws *G* square the jig with the bed by holding the jig against surface *H*. Suitable stops, straps and bolts secure the jig and bed to the base-plate during these operations.

For boring and reaming the shaft holes *I*, *J*, *K*, *L*, and *M*, two boring bars having suitable cutters and reamers are used, similar to those shown in an article on Jigs and Fixtures, in MACHINERY, March, 1909, issue, Figs. 137 and 142, except that in the present case a middle support enables each bar to carry two cutters and two reamers. The jig is provided with removable hardened steel drill bushings for the housing bolt holes *N*, the tapping being accomplished at the same setting of the spindle. Drill and reamer bushings are used at *O* and *P*, while a fixed drill bushing *Q* permits a small hole to be drilled for the taper dowel pin, ample stock being left for reaming after the housings are bolted on and properly located. After the boring and drilling operations are completed, the bed is moved over to the erecting foundation where the erecting process proper begins.

Drilling the Housings

In Fig. 4, the front housing is shown at *A*, with jigs *B* and *C* in position for

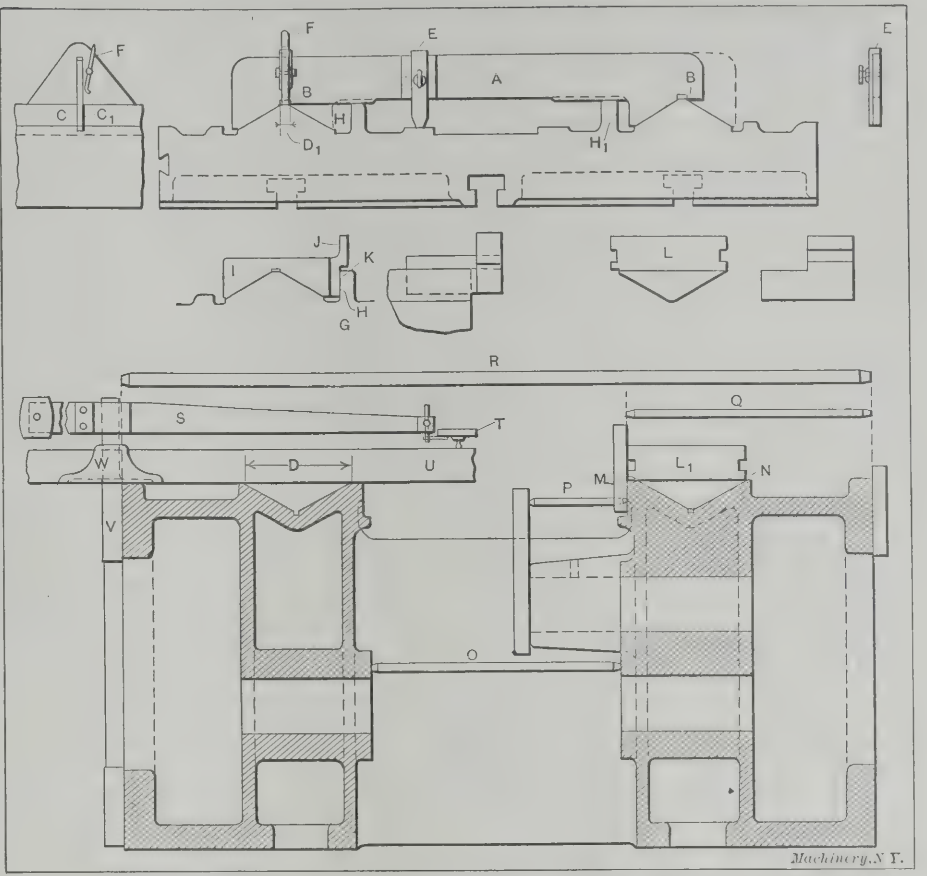

Fig. 2. Gages used for Testing Planing of Bed and Table

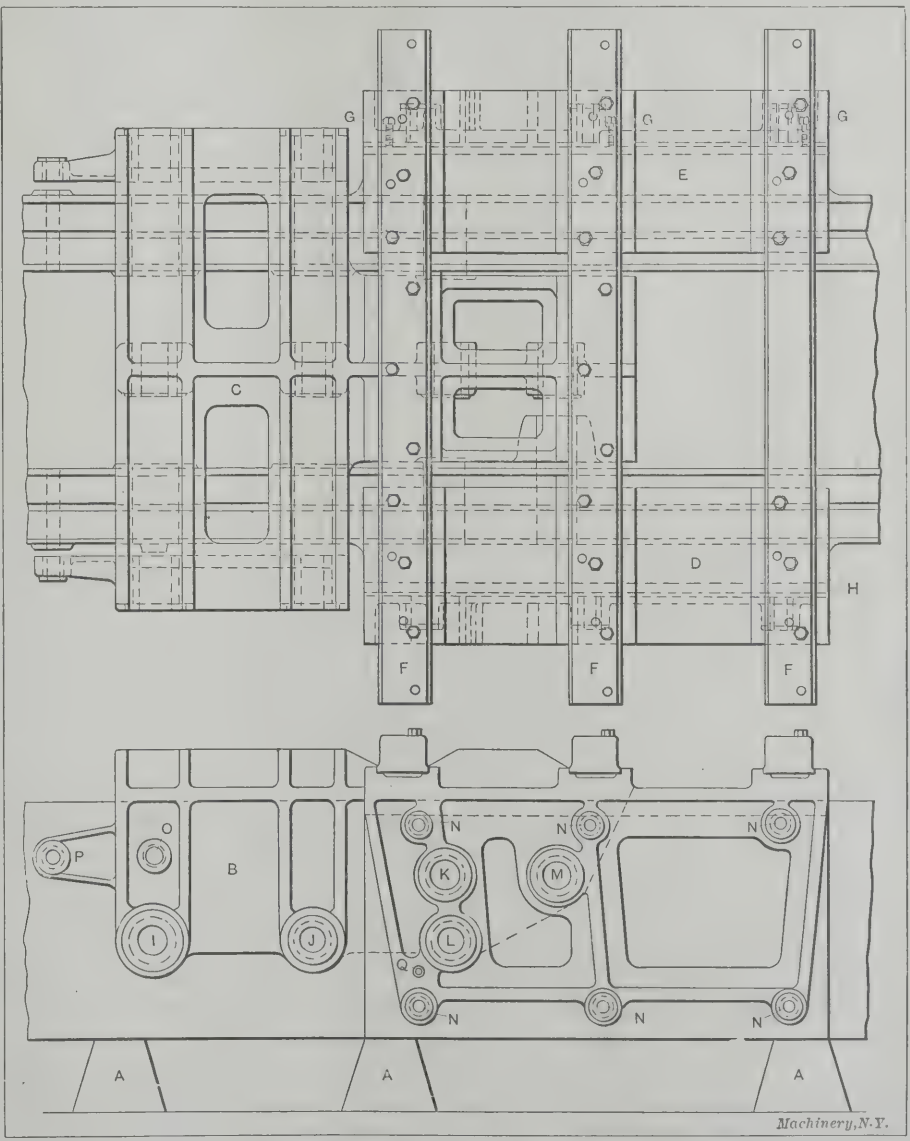

Fig. 3. Combination Boring and Drilling Jig in Position on the Bed

drilling the cheek bolt holes and the arch seat tap holes, respectively; the same jigs are used for the back housing, and jig *C* is also used for drilling the arch casting. The locating points and method of clamping the jigs are indicated in the engraving; as a matter of precaution, after the first hole is drilled in each case, a pin is inserted through the jig bushing into the drilled hole, thus preventing the jig from moving.

All drilling and tapping on this side of the housing being completed, jig *C* is removed, while *B* is secured by four bolts *D* having round heads fitting in place of the drill bushing collars, after which the housing is turned over in the position shown in Fig. 7. The drilling operations are performed on a cast iron base plate provided with a portable motor-driven radial drill, this base also serving the purpose of a surface plate for laying out the work. It is important that the driving shaft bracket hole *A* and feed box shaft hole *C* line up nicely with corresponding holes in the bed, so that the shafts will run perfectly free when assembled. In order to accomplish this without having to assemble the members and housing on the bed, jig *B* is provided with flanged bearings, as at *D*, which support arbors located in the exact center position of the respective driving and feed shafts. The location of the bearings in this jig, and also of the bolt holes *E* is found by clamping the jig to the bed jig member *D*, Fig. 3, and boring the former in this position, so that the two jigs are identical with respect to the locating points and center distances of the various holes.

Referring again to Fig. 7, driving shaft bracket *F* is first centered by the bushing *G* being pushed down into the hole; then the outboard bearing *H* and its member *I* are set approximately correct by means of shaft *J* and jig *K*, and held in this position by C-clamps, after which the truth of bearing *H* with respect to its being square is tested by means of sweep *L*, indicator *M* and test block *N*, as shown in the engraving. When it is determined that bearing *H* is square and properly set, so that bushing *O* enters the hole in jig *K* without springing the shaft, all the clamping bolt holes are marked off, the brackets removed, and the holes drilled and tapped; then the brackets are bolted on, reset in the same manner, and the dowel pins fitted. In setting and testing these bearing brackets, particular care is exercised to insure the accuracy of the work, thereby saving much time when assembling the parts. As was stated at the outset, the fact that these driving works generally are of a special nature, is the reason jigs are not provided for each individual member.

The cam operating lever bracket *P* is marked off after being set lengthways to the correct dimension *Q*, and sideways so that the center line of its shaft will coincide with a line laid off on the housing the right distance from surface *R*. A simple jig for drilling the feed rack casing holes is shown at *S*, the method of locating and clamping it being immediately apparent. Jig *T* is for drilling the feed-box clamping bolt holes; the jig consists of a flat plate centered by means of an arbor the same as at *D*, and located by a pin fitting into housing dowel pin hole *U*. A jig of similar construction and

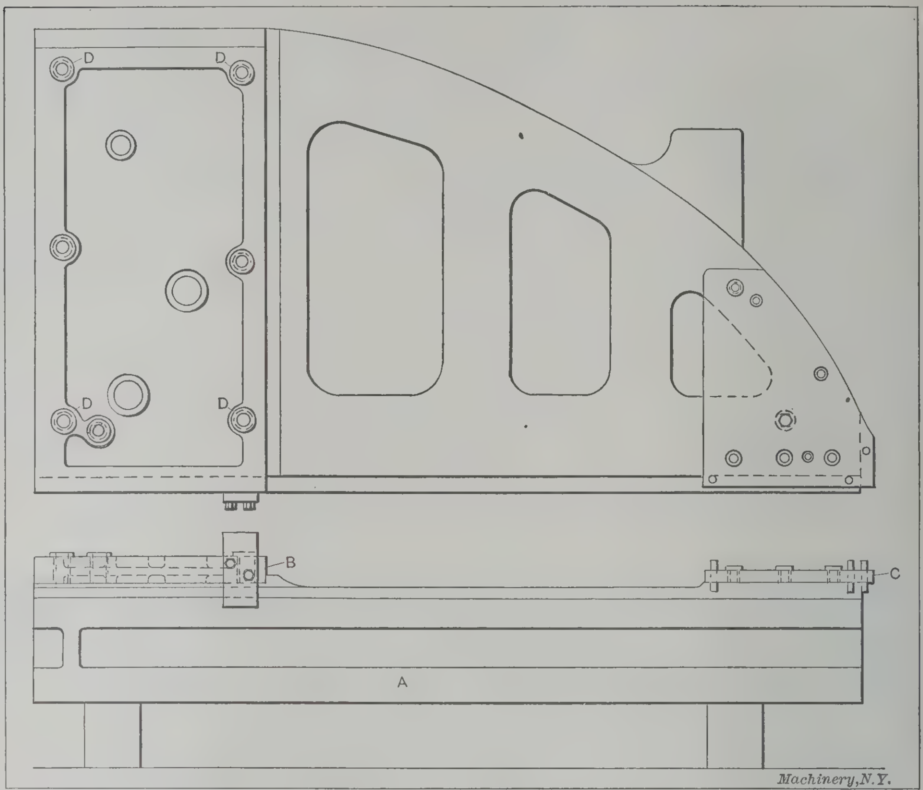

Fig. 4. Front Housing with Jigs in Position for Drilling Clamping Bolt Holes. Same Jigs are used for Similar Operations on the Back Housing

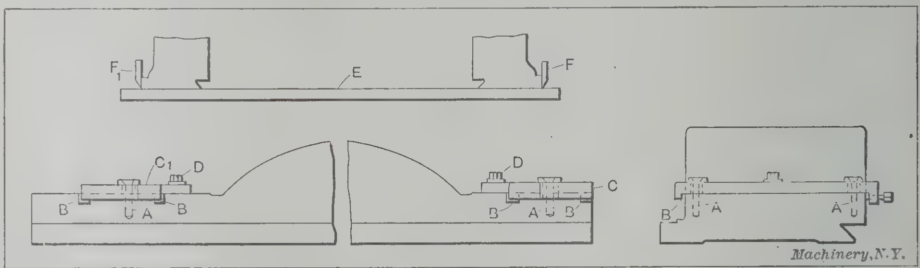

Fig. 5. Jigs for Drilling Stud Holes in Back of Cross-rail. Setting of Jig C_1 Endwise, is accomplished by transferring Measurement from Housings by Means of Wooden Straightedge E

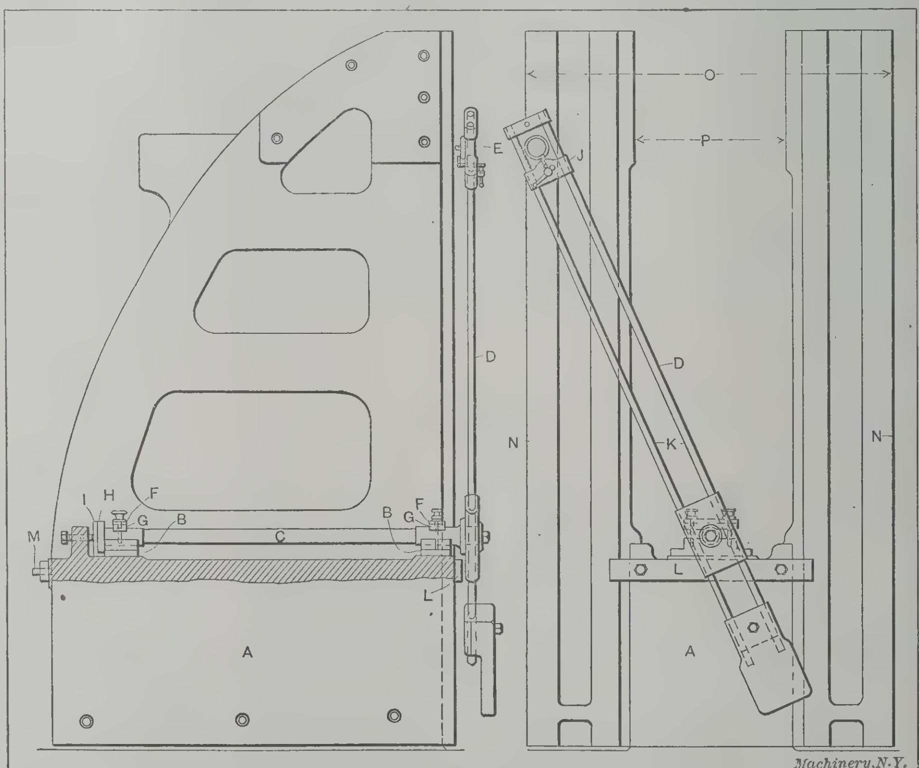

Fig. 6. Special Fixture used for Testing Alignment of Housing Faces and provided with Sweep for Carrying Starrett Indicator

centered in the same manner, is illustrated at *V;* this jig drills the clamping bolt holes for a bracket that carries the side-head feed shaft. Simple jigs, not shown, are provided for drilling for the feed bracket *B* and elevating screw brackets *C*, Fig. 1, these two operations being performed on a horizontal drill. This completes the drilling on the front housing, and after the necessary drilling is performed on the back housing, using the same jigs as previously explained, the housings are tested to determine the accuracy of the planing.

Testing the Housings

One of the essential requirements of a first-class planer is that it must produce accurate work when using the side-heads, and this means that the ways on the housings be perfectly true and parallel. When making this test, as shown in Fig. 6, the housings occupy the same position as when assembled on their bed, and it is at once apparent that whether or not the front faces stand perfectly plumb, is a matter of little consequence, so long as the faces lie in the same plane. With respect to the side faces and angles, however, the conditions are different; these must be square with the bed. Casting *A* which corresponds to the cheeks on the planer bed, is bolted to a suitable concrete foundation and carries two V-blocks *B*, forming bearings for the sweep bar *C* which in turn supports sweep *D* and indicator *E*. The bar is held in the V-blocks by straps *F* and wooden blocks *G*, while collar *H* and its thrust bearing *I* take up all lateral motion. The construction of sweep proper, *D*, is such that clamp *J*, carrying the indicator, may be secured in any position of its travel between the two seamless steel tubes *K*, which enables readings to be taken at various points.

After being bolted onto the jig, the housings are located against strap *L* by means of screws as at *M*. It is desirable that the front faces show about 0.001 inch low at their outer edges, as at *N*, so that when the cross-rail is in position it will surely have a bearing across the entire face of each housing. Measurements are also taken across *O* at various heights, and between the arch seats *P*, to determine the parallelism of these surfaces. It should be explained that, in the side view, the front housing only is shown for the purpose of more clearly illustrating the sweep bearings. The housings having passed inspection in this test, are next turned face uppermost in a suitable pit for convenience in scraping on the side-head shoes *D*, Fig. 1, after which the housings are ready to be placed in position on the bed.

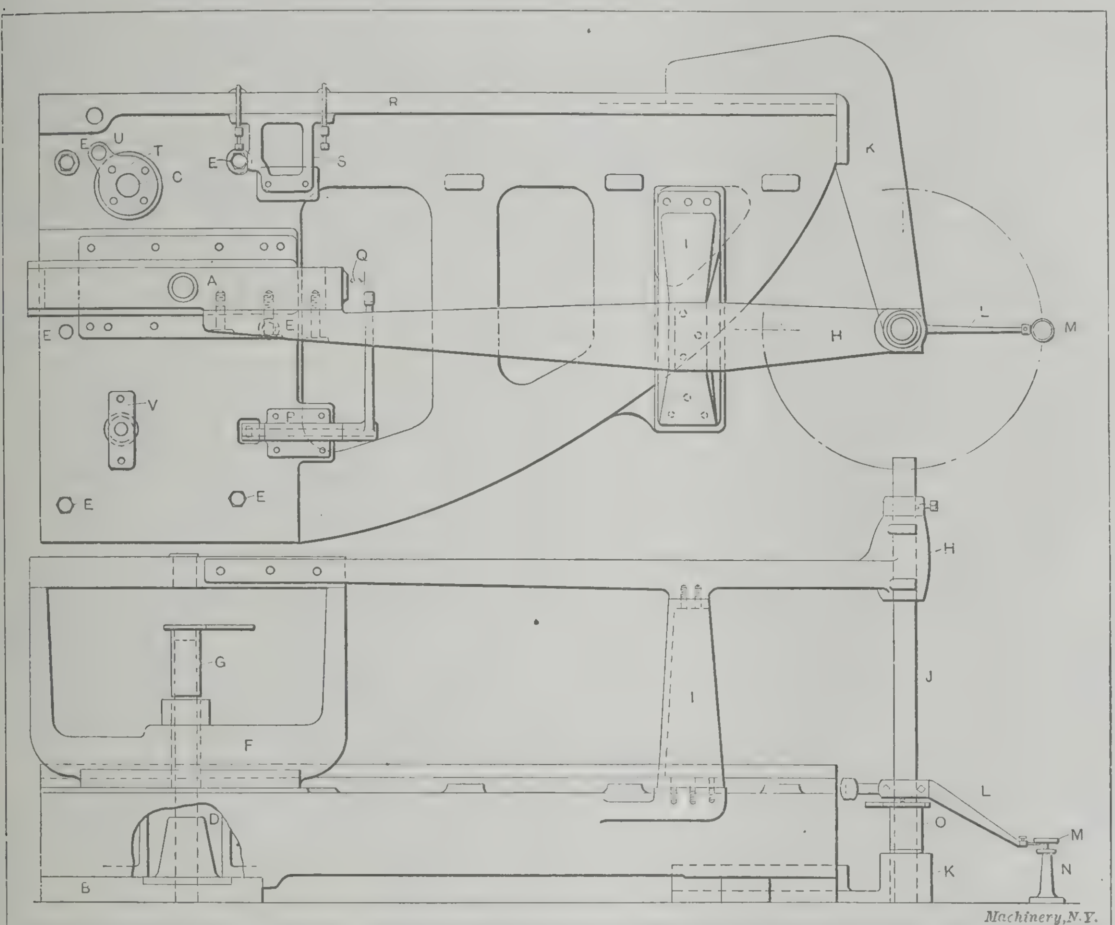

Fig. 7. Method of Setting and Laying out Holes for the Driving and Feed Members on the Front Housing

* * *

MODERN CONDENSER PERFORMANCE

Steam engineers in the past have generally considered that, from the standpoints of coal consumption and plant operation, the reciprocating engine gained little from a vacuum above 26 inches of mercury. This opinion was in part due, especially in marine circles, to the practice of driving the auxiliaries from the main engine, so that, there being no auxiliary exhaust to heat the feed, a lower vacuum meant hotter feed water. The steam turbine, however, because of its ability to deal efficiently with steam in large volumes, easily shows a gain of from 5 to 10 per cent in steam economy for every additional inch of vacuum above 26 inches, and the heating of the feed water is properly left to the economizers or to heaters utilizing the exhaust of auxiliaries. The premium thus put upon condenser performance has resulted in a closer scrutiny of the several processes which go on in a condenser.

The activity of the several groups of tubes in a surface condenser can be quite accurately inferred from the rise in temperature of the water passing through them. By inserting thermometers in the water-boxes it has thus been discovered that in the ordinary surface condenser most of the heat is absorbed—that is, most of the steam is condensed—in the first few rows at the top. The transmission of heat through condenser tubes may be affected by the flooding of the lower tubes by the water descending from those above or by the tubes being immersed in air. The velocity of the steam and of the circulating water, and the cleanliness of the tubes, are also governing factors.

While much scientific investigation has been devoted to the effects of water velocity and of steam velocity, the possibilities of improvement in this direction are limited by the fact that excessively high steam velocities mean back pressure while high water velocities involve the consumption of an excessive amount of power in the circulating pumps. The avoidance of air-drowning and of the flooding of the tubes has, however, resulted in greatly reducing the amount of condenser tube surface for a given amount and temperature of circulating water; that is, with the same surface, less, or water of a higher temperature, will maintain the same vacuum.

Air-drowning is prevented by avoidance of air leaks, provision of sufficient air pump capacity and arrangements for removing the air at the lowest possible temperature and hence at the greatest density. The flooding of tubes has been met in various ways. To avoid this flooding effect, the four "Dry Tube" condensers, installed by the Wheeler Condenser and Engineering Co. in the Williamsburg power station of the Transit Development Co. of Brooklyn, are equipped with horizontal baffle plates which are interposed between the sev-

eral banks of tubes. The exhaust steam from the double-flow Westinghouse turbines installed on the floor above, enters the condensers at the top and upon condensing falls upon these baffle or rain plates, which catch the water and carry it to the outside against the shell, down which it flows to the hot well without coming in contact with other tubes. To permit the passage of the steam past these rain plates there are openings, around the edge of which the plate is turned up to form a vertical lip, preventing an overflow of water. These openings are so staggered that the steam will reach all parts of the tubes, insuring complete utilization of all the surface. Simple as this expedient appears, the results obtained by means of it have been remarkable, as will be apparent from a consideration of the rate of heat transfer developed in this condenser under working conditions. It was formerly customary to assume the rate of heat transfer through surface condenser tubes, closed feed water heaters, and similar appliances as between 200 and 300 British thermal units per square foot per hour per degree difference of temperature between the water inside the tubes and the steam outside.

After a series of tests of one of the condensers in the plant referred to, which was designed to handle 180,000 pounds of steam per hour and to give a vacuum equivalent to 2 inches absolute pressure with 70 degrees F. circulating water, the transmission of heat per square foot per hour per degree difference of temperature was found to be between 800 and 900 British thermal units which is two to three times greater than is obtained from the ordinary surface condenser. During the tests the rate of condensation varied from 164,586 pounds to 220,200 pounds of steam per hour. These results show that the guaranteed vacuum could have been maintained with even less condensing surface than was actually installed, although the latter is considerably below usual practice. That is, while the ordinary condenser would contain 2 or 3 square feet of surface per rated horse-power, this condenser contains only 1.5 square foot per rated electrical horse-power.

With the jet condenser, it is not so much a question of improving the rate of heat transmission as of insuring thoroughness of intermixture, that is, of bringing each particle of water so intimately in contact with the steam that it will be heated to the steam temperature and its full capacity for absorbing heat realized. This is desirable in order to reduce the amount of circulating water and to prevent loss of temperature in the hot well. By reducing the amount of circulating water, the power required for pumping it is minimized and less air is brought into the condenser. At first thought it would seem an easier and simpler matter to secure high temperature in the circulating water leaving a jet condenser than in that leaving a surface condenser, since in the jet condenser the water and steam come into actual immediate contact; nevertheless, the fact remains that the water discharged from most jet condensers does not rise nearer than to within 10 to 20 degrees F. of the temperature of the steam.

The results of tests of a Wheeler "Rain Type" jet condenser connected with a Westinghouse-Parsons 1,000-kilowatt steam turbine are given in the accompanying table.

Vacuum, inches	Absolute Pressure, Ins. Mer.	Corresponding Temp.* of Exh. Steam	Injection Temperature In	Injection Temperature Out	Difference in Temp. of Steam and Cir. Water
28.65	1.25	85.5	44	85	0.5
28.7	1.2	85.	44	85	0.0
28.7	1.2	85.	44	83	2.0
28.75	1.15	83.5	44	80	3.5
28.75	1.15	83.5	44	81	2.5
28.55	1.35	88.5	44	87	1.5
28.75	1.15	83.5	43	79	4.5
28.75	1.15	83.5	43	76	7.5

* Temperatures given in degrees Fahrenheit

As will be seen, the outgoing circulating water kept within from ½ to 7½ degrees of the temperature corresponding to that of the exhaust steam. This condenser is of a new design and is so constructed that the steam enters through an opening at the left, passes horizontally across through a shower of water, ascends to the second level, passes to the left through an upper shower, and finally all that is left of the steam vapor together with the air, and other gases, passes horizontally to the right, and over the entering and coldest water at the top to the dry vacuum pump suction opening in the uppermost part of the shell. The water is introduced at the upper right hand corner into an extended trough or pan, from which it overflows through numerous short tubes, falling into a second and similar pan provided with similar overflow pipes and weir, and finally falling into the lower part of the shell, and overflowing thence to the barometric column or to the centrifugal or other type of pump serving to overcome the atmospheric pressure. The water is finely divided by small baffle plates hung below the tubes.

On the day of the test, the barometer stood at 29.9 inches, while the street railway load on the turbine varied from full load to 10 per cent overload. Temperature readings were taken by thermometers placed in the exhaust pipe and in the hot well, while the vacuum readings were taken from a mercury column connected directly to the condenser. The number of pounds of circulating water required to condense 1 pound of steam was found by calculation to be 24.3. As a matter of fact, the amount would be less than this, since not all of the exhaust is steam when it arrives at the condenser, some of it having already condensed in the turbine and in the exhaust pipe, due to work performed and to radiation.

* * *

LENGTH OF RECESS IN THE BORE OF MILLING CUTTERS

The accompanying table has been compiled with a view of giving at a glance the length of recess in the bore of milling cutters, including cutters from one-half inch width of face up to cutters six inches long. It will be seen, by studying the

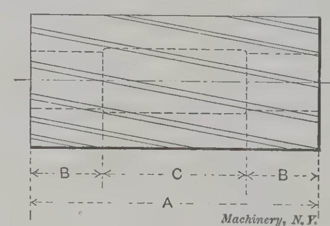

TABLE GIVING LENGTH OF RECESS IN THE BORE OF MILLING CUTTERS

Length of Cutter	Length of Bearing at Each End	Length of Recess	Length of Cutter	Length of Bearing at Each End	Length of Recess	Length of Cutter	Length of Bearing at Each End	Length of Recess
A	B	C	A	B	C	A	B	C
1/2	1/8	1/4	2 3/8	5/8	1 1/8	4 1/4	1 1/16	2 1/8
5/8	3/16	1/4	2 1/2	5/8	1 1/4	4 3/8	1 1/16	2 1/4
3/4	3/16	3/8	2 5/8	11/16	1 1/4	4 1/2	1 1/8	2 1/4
7/8	1/4	3/8	2 3/4	11/16	1 3/8	4 5/8	1 1/8	2 3/8
1	1/4	1/2	2 7/8	3/4	1 3/8	4 3/4	1 3/16	2 3/8
1 1/8	5/16	1/2	3	3/4	1 1/2	4 7/8	1 3/16	2 1/2
1 1/4	5/16	5/8	3 1/8	3/4	1 5/8	5	1 3/16	2 5/8
1 3/8	3/8	5/8	3 1/4	13/16	1 5/8	5 1/8	1 1/4	2 5/8
1 1/2	3/8	3/4	3 3/8	13/16	1 3/4	5 1/4	1 1/4	2 3/4
1 5/8	7/16	3/4	3 1/2	7/8	1 3/4	5 3/8	1 5/16	2 3/4
1 3/4	7/16	7/8	3 5/8	7/8	1 7/8	5 1/2	1 5/16	2 7/8
1 7/8	1/2	7/8	3 3/4	7/8	2	5 5/8	1 5/16	3
2	1/2	1	3 7/8	15/16	2	5 3/4	1 7/16	2 7/8
2 1/8	9/16	1	4	15/16	2 1/8	5 7/8	1 7/16	3
2 1/4	9/16	1 1/8	4 1/8	1 1/16	2	6	1 1/2	3

figures in the table, that, in general, the length of the recess is about half of the total length or width of the face of the cutter, and the length of the bearing at each end is about one-quarter of the total length. A.

* * *

A remarkable demonstration of the possibilities of gas producers and producer gas engines for boat propulsion was described in the August issue of the *International Marine Engineering.* A boat 40 feet long over-all, 9 feet beam, driven by a four-cylinder 35 horse-power gas engine, covered between 800 and 900 miles at an average speed of from 8 to 9 miles an hour on one ton of pea anthracite coal, used for producing the gas in a small gas producer installed on the boat. In addition to the greater safety, it is stated that the cost of operation is about one-tenth that of a gasoline engine using gasoline at fifteen cents a gallon.

INTERESTING TOOLS AND METHODS OF CINCINNATI SHOPS—2

THE LODGE & SHIPLEY MACHINE TOOL COMPANY

ETHAN VIALL*

The names of Spring Grove and Colerain Avenues become very familiar to the man who visits the Cincinnati tool and machine tool shops—more so perhaps than the names of any

Fig. 1. Paved Court at the Lodge & Shipley Plant for Teaming Purposes

other streets there, for some of the best-known machine tool building shops in the world are easily reached by taking the cars that run from Fountain Square in the heart of the city

Fig. 2. Lathe Bed Storage House with Traveling Crane and Sliding Doors along the Side

out along these two avenues. It is worth while for any mechanic who can possibly do so to take the time to go through a few of these shops at least, and all of them if he can, and naturally, even if only a few were selected, he would not overlook as large and well-known a plant as that of the Lodge & Shipley Machine Tool Co., at 3055-3065 Colerain Ave., which makes nothing but lathes and lathe attachments or fittings, and where he will be given a hearty welcome and a guide who will show and explain everything to him that is worth while. In a trip through this plant, a reader of MACHINERY would see many old mechanical acquaintances in the line of tools and methods that have been introduced to him from time to time through these columns, yet there are many things to be seen which have never been described and many things impossible to describe—adequately at least. The present article does not aim to go very deeply into descriptions of shop methods or practice, but simply to present a few of the "high spots" touched here and there in a recent tour of inspection.

System and neatness prevail everywhere and many time- and labor-saving devices are to be found on every hand. The old way for a workman to get the big traveling crane, by going out in the runway, waving his arms like a windmill and yelling until he was hoarse, at the sleepy crane operator two or three hundred feet away, has all been done away with, and now the workman presses one of the buttons set at convenient distances along the shop runway, a red light is flashed in plain view of the crane man and, unless already employed, he at once runs his crane to where it is needed. Then, too, there is a messenger system in use that obviates the necessity of a machinist leaving his work to get a new jig or tool, as he has only to press a button close to his machine and an annunciator near the tool room indicates to a waiting messenger boy where he is wanted, as all machines are numbered; he then goes at once and finds out what is wanted, gets it for the man and returns to his place ready for another call.

The traveling crane system is unusually complete and is so arranged that castings can be removed from a wagon by the yard crane and stored, or carried within reach of one of the shop cranes. New machines are loaded with the same ease. The court into which the heavy wagons are driven for loading or unloading is shown in Fig. 1. This is well paved and drained and is large enough for several teams to maneuver in at once. In this engraving the main shop is partially shown in the background; shop Number 2 is at the left and one of the storage sheds is in between the two.

In Fig. 2 is shown the way lathe beds are stored, some of these being in the rough, while others are partly finished and left here to "season." Lathe carriages are stored close to the assembling floor in upright racks, as shown at the right in Fig. 3, and compound rests on the iron shelves covered with cloth, shown at the left.

A satisfactory and economical way to stack quantities of round bars of various sizes and lengths, is often a puzzle to the man in charge of stock, but the problem has here been very happily solved, as shown in Fig. 4, by using short lengths of square iron bars curved up at each end and placing them

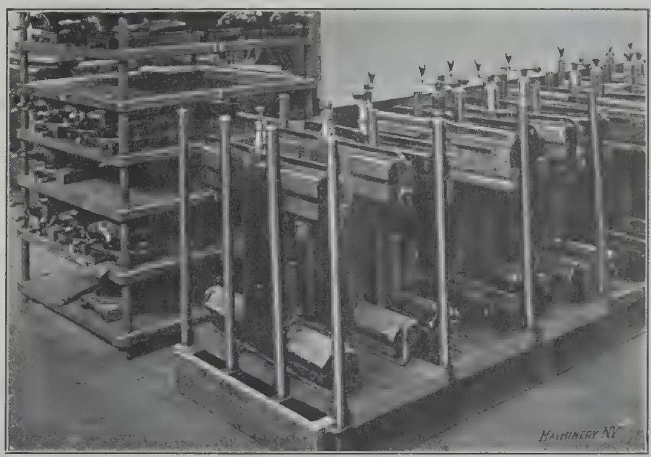

Fig. 3. Racks and Shelves for Holding Carriages and Compound Rests

as shown. Where a rack of some kind is wanted for storing large amounts of stock, a very good type is shown in Fig. 5. This rack has adjustable supports for the cross-pieces, so that

Fig. 4. Method of Piling Round Stock, which is both Convenient and Economical as to Space

compartments, to suit the different sizes or amounts of stock, can be readily arranged.

In the machine shop, a portable motor-driven variable-speed countershaft, shown in Fig. 6, is used to run lathes that are being assembled or tested. A planer equipped with a regular Lodge & Shipley variable-speed lathe countershaft (Fig.

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7) is something unusual, but it ought to be very handy for some classes of work.

The hand scrapers used by the assemblers and fitters are sharpened on the portable oil-stones shown in Fig. 8. These stones are motor-driven and may be set in any convenient place close to the machine or machines upon which a group of men may be working.

After the gears and parts of a lathe head are in place, the shift-gear lever-lock holes *A*, Fig. 9, are drilled in the head-casting so that they will line up properly with the correct position of the lever and gears. This is done by removing the locking pin from the lever, meshing the gears, spotting each hole to be drilled in turn through the locking pin hole, and then finishing the holes, using the electric drill and adjustable stand shown. Braces and locks to hold the drill to the work for this and other jobs are shown lying on the floor.

Fig. 5. An Adjustable Storage Rack for the Stock-room

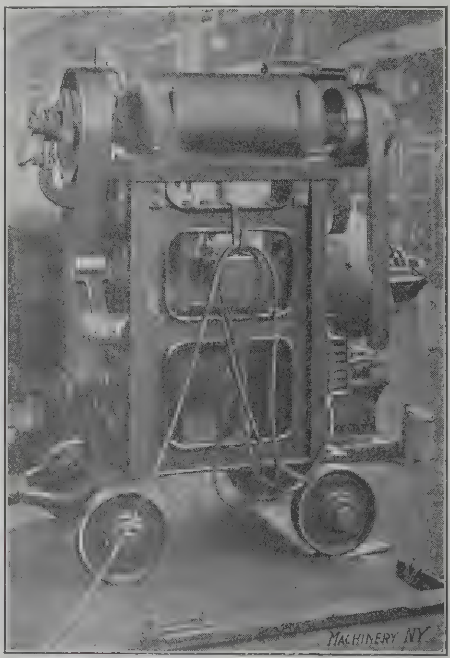


Fig. 6. Movable Variable-speed Countershaft for Testing Purposes

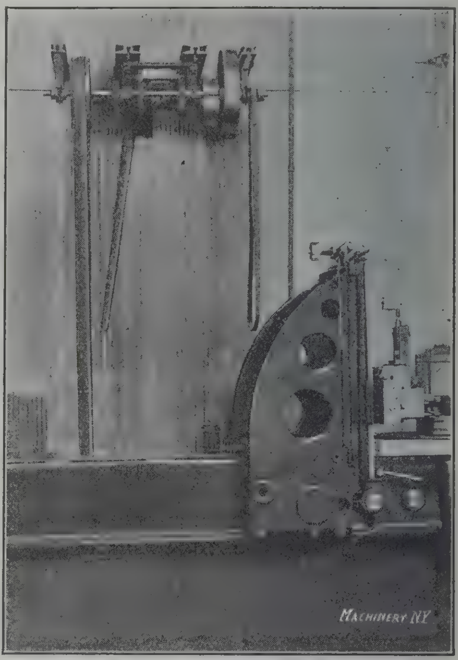


Fig. 7. Planer equipped with a Lodge & Shipley Variable-speed Lathe Countershaft

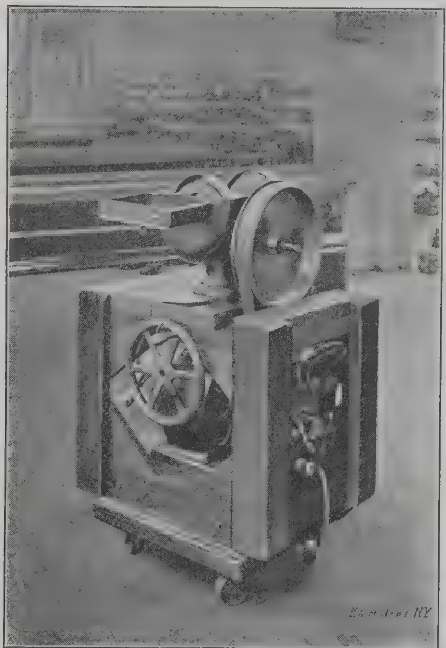


Fig. 8. Portable Scraper Grinder

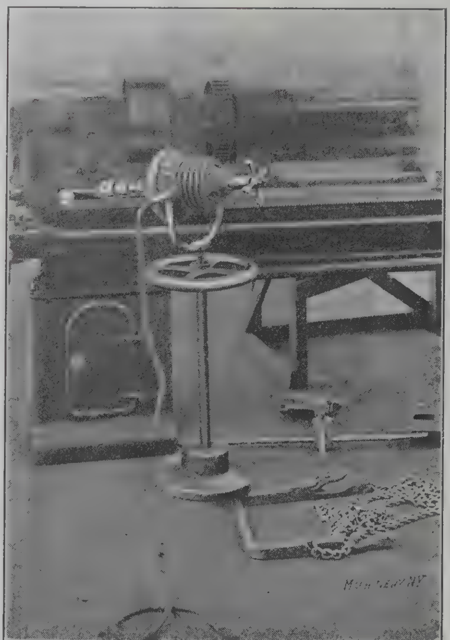


Fig. 9. Adjustable Electric Drill and Brackets

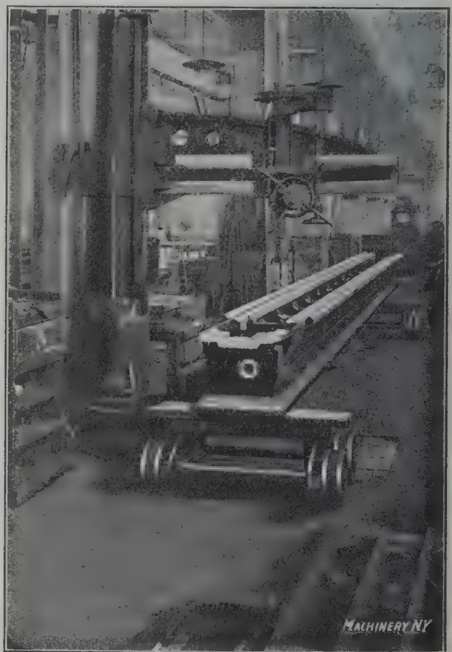


Fig. 10. Drilling Large Lathe Beds

Large lathe beds are placed on the four-wheeled trucks, Fig. 10, while the different holes are drilled with a big radial drill, and in this way the huge castings may be moved along with comparative ease. The ends of these large beds are faced off with the portable milling machine shown in Fig. 11.

Hand-wheels of all kinds have the rims ground on the special machine shown in Fig. 12, which does splendid work and is very conveniently and rigidly built. The emery wheel spindle is run with a belt in the usual way, but the spindle carrying the work is driven by a universal jointed shaft and set of bevel gears, connected to the countershaft, in the same way that drills in a screw machine turret are independently driven. The work is fed up to the grinding wheel by means of the ball-crank *A*; a rotary movement is given to the table by turning the hand-wheel *B*. The wheel to be ground is fastened on the end of the work spindle by a nut and it is kept from turning by a pin in the face-plate which engages one of the spokes.

The small straightening block or screw-press (Fig. 13) is made considerably lighter than usual by bracing the top with an eye-bolt as shown, which makes it just as good for most purposes. It is also easier to handle because of the decreased weight.

Bushings like *A*, Fig. 14, are screwed into the lathe aprons by taking advantage of the oil groove in them and using it for a wrench-hold, the wrench-plugs *B* being made with a corresponding ridge.

Small reverse-plate gear-bushings are held while turning the outside, as shown in Fig. 15. The mandrel used is fastened securely in the lathe spindle and has a pin or key in it which fits into the oil notch in the bore of the gear-bushing and keeps it from turning. The outer end of the mandrel is supported by the tailstock spindle of the lathe which has been fitted with a bushing for the purpose. This spindle also has

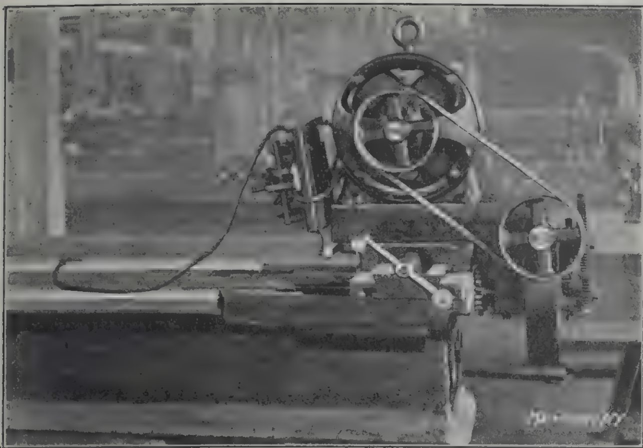


Fig. 11. Portable Milling Machine for Facing Ends of Large Lathe Beds

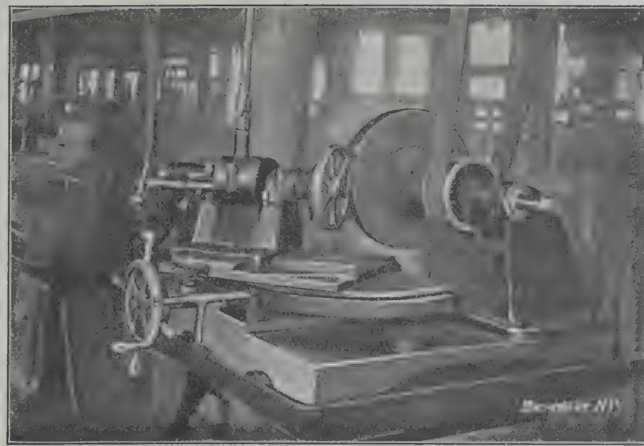


Fig. 12. Special Machine for Grinding Rims of Hand-wheels

Fig. 13. Straightening Block with Top Brace

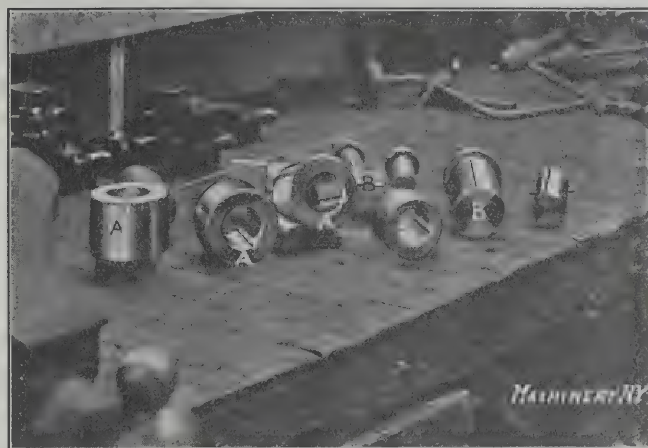


Fig. 14. Apron Bushings and Plugs used for Screwing them in.

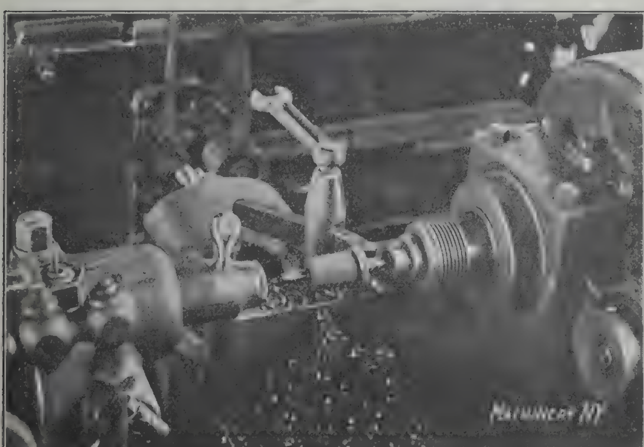


Fig. 15. Special Mandrel used to hold Reverse Plate Gear Bushing

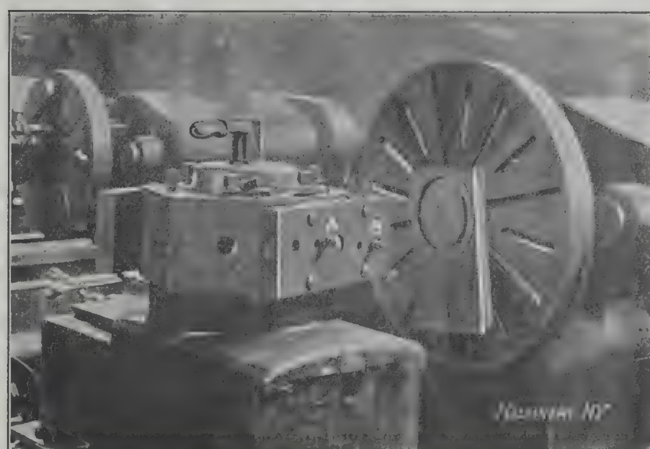


Fig. 16. Cutting T-slots in Lower Compound Slide

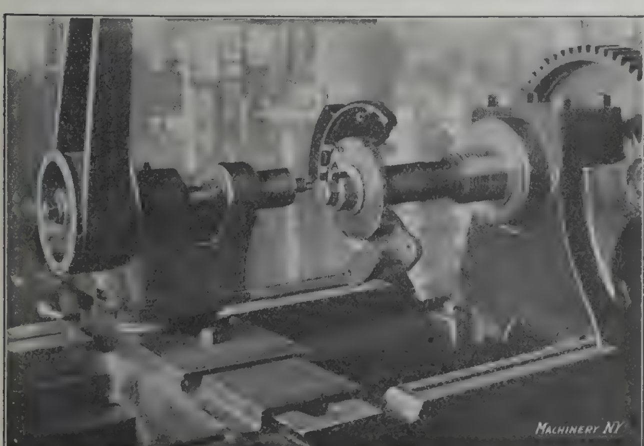


Fig. 17. Milling Contact Spots on Countershaft Friction Parts

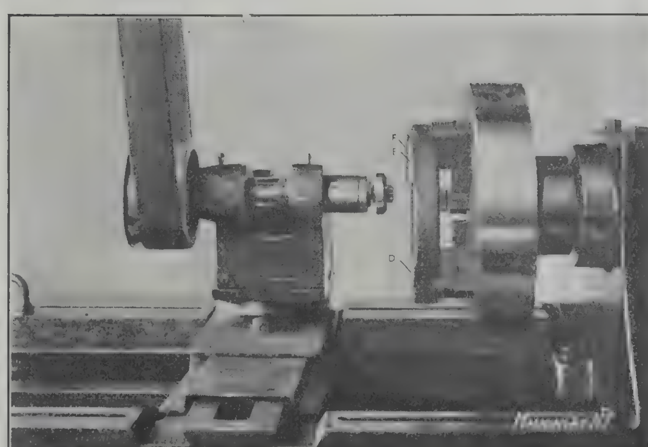


Fig. 18. Milling Friction Bands for Countershafts, in the Lathe

a handle attached so that it can be shifted out or in easier while taking off or putting work on the mandrel.

Fig. 16 shows how the circular T-slots are cut in the compound rest bottom-slides. They are located on the face-plate by means of a plug mandrel in the lathe spindle, which fits the hole bored in the casting. The circular slot is cut out by using the two cutters *A* and *B*, shown in the turret, and feeding them straight in. The slot is then made T-shape by

using two L-shaped tools set in the turret in a way similar to *A* and *B*. These tools are run in flush with the bottom of the slot which is finished by cross feeding the turret the desired amount.

The "spots" *A*, *B* and *C*, Fig. 17, on the countershaft friction parts, are milled on a lathe, to the carriage of which has been fitted the fixture shown. The friction band is milled at *D*, *E* and *F*, Fig. 18, using the same fixture, with another cutter which machines both the face and outside of the contacts at once while the casting is held in a regular lathe chuck.

Fig. 22 shows the series of jigs used to hold lathe heads on the planer, and Fig. 23 shows a lot of lathe carriages being planed up for the cross-slides.

This article would not be complete without a brief description of a few of the many things that are provided for the comfort and welfare of the employes. In Fig. 24 is given a partial view of the neat washroom with its individual wash basins, and along the walls are shown dust-proof individual lockers for the men's clothing and lunch boxes. Ample space is also provided elsewhere for bicycle storage.

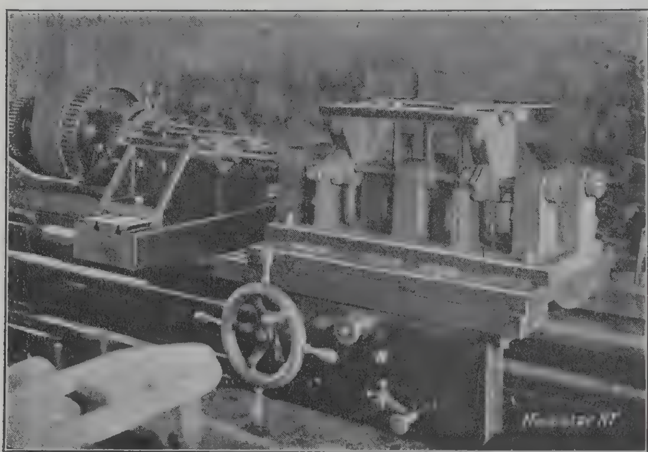


Fig. 19. Jig for boring Countershaft Brackets

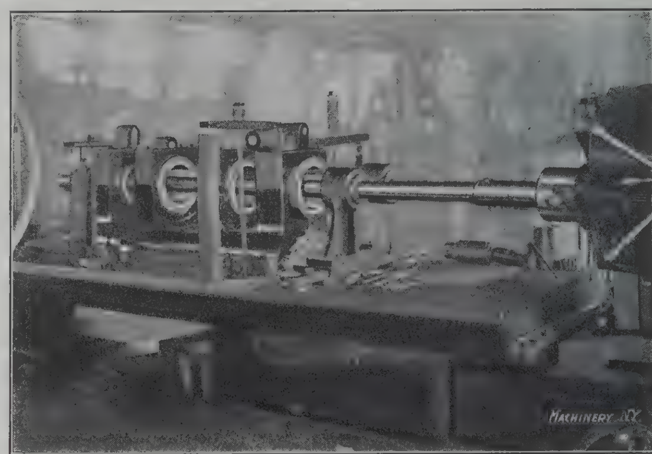


Fig. 20. Boring Lathe Heads

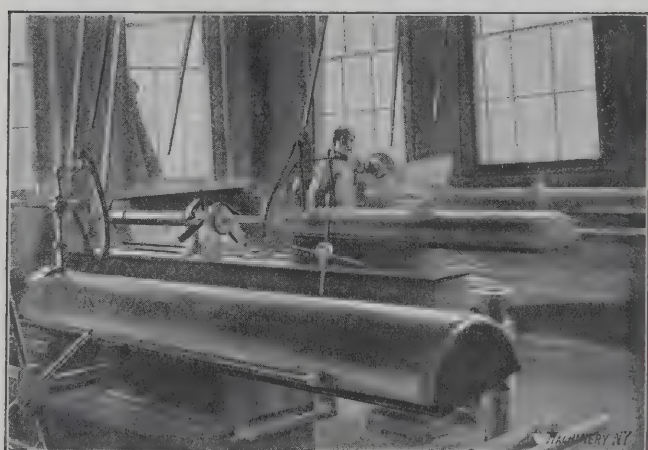


Fig. 21. Group of Special Spindle-drilling Machines

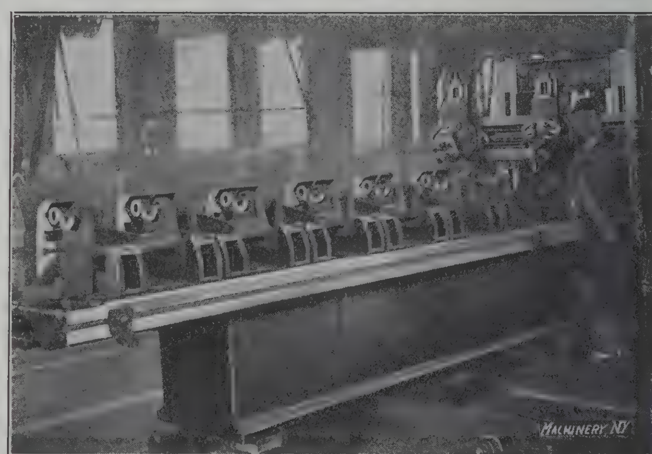


Fig. 22. Fixture for Head-stock Planing

Fig. 23. Planing Lathe Carriages

Fig. 24. Employes' Locker and Wash-room

Countershaft brackets are bored out while held on a lathe in the jig shown in Fig. 19, using a double-headed boring fixture operating two boring-bars at once.

Lathe heads are bored out as shown in Fig. 20. All lathe spindles used in this shop are drilled out of solid metal on the machines shown in Fig. 21. The standard method of rotating the work and feeding in the drill is used in these machines. Lodge & Shipley also makes a motor-driven lathe attachment for deep drilling.*

* Complete information on this subject will be found in MACHINERY'S Reference Series No. 25 on Deep Hole Drilling. A description of the Lodge & Shipley deep hole drilling attachment will also be found in this pamphlet.

The employes have a mutual benefit association, which for a small sum provides a fair amount of protection for members who are sick or injured.

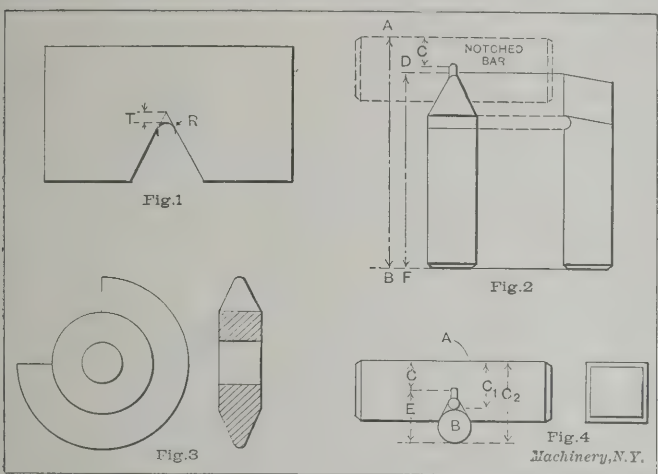
* * *

The electrification of a street railway line in London has been brought to a standstill on account of possible disturbances to the delicate instruments at the Greenwich observatory. The Astronomer Royal has the power to pass upon any undertaking within three miles of the observatory that is liable to affect the instruments, and the railroad company must obtain his consent before proceeding with the electrification.

MAKING WHITWORTH THREAD TOOLS*

In order to produce interchangeability in screw threads, the tools for the screw cutting operations require very careful consideration. Even with accurate tools, the form of thread cut by any threading device depends considerably on the material in which the thread is cut. For instance, a tap used to cut a thread in cast iron is withdrawn with ease, but when the same tap is used in machinery steel it is not as easily withdrawn, the cause evidently being that the threads in the cast iron are thinner and that the pitch diameter of the screw thread is correspondingly increased. This being the case, it is very evident that it is necessary to have the original thread cutting tool as nearly perfect as possible, in order that the subsequent deviations may be minimized. A method is briefly described for generating and measuring thread tools for cutting threads with rounded top and bottom, such as the Whitworth and British Association standard threads.

In the specifications of these standards the radius of curvature, R in Fig. 1, at the top and bottom is given. In originating tools for these thread forms templets are usually made



Figs. 1 to 4. Whitworth Thread Tools and Methods used for Making

by drilling a round hole of the required radius and cutting an angular notch with sides running tangentially into the hole as shown. Fairly accurate work can be done in this way, but a method originated by Mr. W. Taylor permits of greater accuracy in gaging the angle of the thread tool, this being of more importance than the exact curvature of top and bottom.

In shaping the original thread tool as shown in Fig. 2, a notched bar of hardened steel, as shown in Fig. 4, is used for measuring. The face A of this bar is lapped flat, the V-notch is lapped so that its center is perpendicular to A and apex of the V-notch. Anyone familiar with trigonometry can easily calculate the dimensions C and E when C_1, C_2, the angle of the notch, and the diameters of the cylindrical gages are known. This notched bar is applied to the tool as shown by the dotted lines in Fig. 2, the angular faces of the tool having been previously ground. The total distance AB is measured, and from this we subtract the constant dimension C of the bar and the distance T, Fig. 1, from the rounded surface of the thread to the true apex of the V-point of the tool. We then obtain the required finished length DF, Fig. 2, to which the tool must be shortened by rounding its extreme point.*

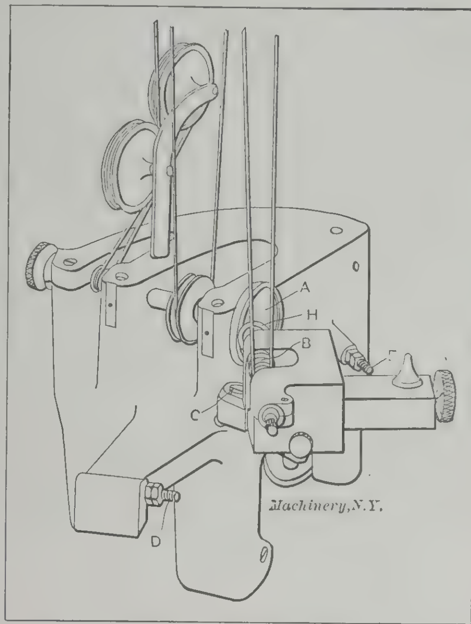
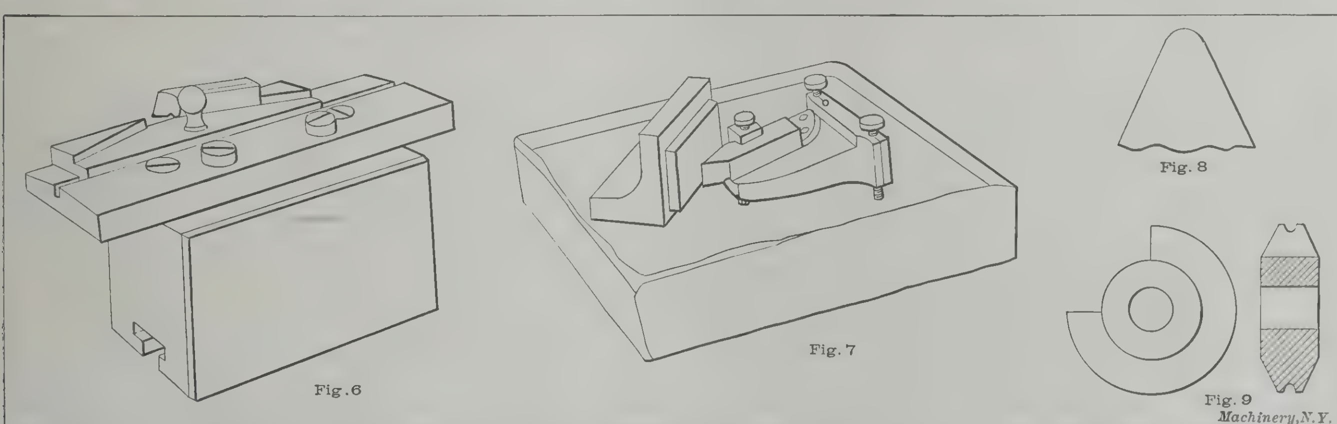


Fig. 5. Machine for Grinding Circular Formed Thread Tools

In rounding the tool point the radius of the curvature is not directly measured. It is sufficient that the curve be circular, that the angular sides of the tool join it tangentially, and that the distance from the top of the curve to the apex of the tool angle be obtained correctly by measurements as described. The first two conditions above are most easily obtained in circular formed threading tools of the shape shown in Fig. 3, which can be sharpened without losing their form. Cutters of this form are invaluable for constant use, but cutters shaped as shown in Fig. 2 can be made by simple means.

The grinding machine shown in Fig. 5 is used for forming correctly the circular tool. In this the previously shaped and hardened cutter is finished by grinding with a cup-shaped wheel A, which, while rotating, moves in an eccentric circular orbit so it wears truly flat. The cutter H is mounted and rotated on the horizontal spindle B, and while rotating can be swung around a vertical axis C as far as permitted by the stops D and E, which are set so as to limit the movement to the angle of the tool (55 degrees for the Whitworth thread).



Figs. 6 and 7. Appliances for Making a Tool with Rounded Nose or Cutting Point and with the required Clearance Angle, as shown in Fig. 2

Fig. 8. Enlarged View of Tool Point made by the Process described. Fig. 9. Tool for Forming Top of Thread

so that it has the thread angle required. Its apex is cut away entirely, as shown, and by means of two or more small cylindrical gages placed at B, the measurements C_1 and C_2 are taken, by which the accuracy of the angle may be verified and from which is found the distance C between the face A and the true The tool, when ground, is again tested by the notched bar in Figs. 2 and 4.

In Fig. 6 is shown a simple holder with guides mounted on a slide, which serves to support the tool shown in Fig. 2, and

* From a paper entitled Interchangeability and Methods of Securing it in Screw Threads, read before the Institution of Mechanical Engineers of Great Britain, by Mr. H. F. Donaldson.

* A description of a method used for measuring, by the micrometer, the amount to be removed from a Whitworth tool having front clearance was included in an article entitled "Measuring Width of Flat on U. S. Standard Thread Tools," MACHINERY, April, 1907.

present it accurately to a flat-faced rotating metal lap so as to grind the angular sides of the tool point. In Fig. 7 is shown a holder with adjustable feet and with a stop against which the tool may be clamped. This is placed upon a piece of plate glass and worked against a small angle plate faced with an Arkansas oil-stone. With these simple appliances, and with the exercise of a little skill, it is possible to round the tool point so accurately that when magnified 100 to 200 diameters and compared with the circular field of a microscope, no error is perceptible. In Fig. 8 is shown a tool point of a British Association standard thread No. 6 rounded in this way, magnified 30 diameters, and correctly copied. In Fig. 9 is shown the form of the tool used to round the top of the threads, the groove not being as deep as that of a full half circle.

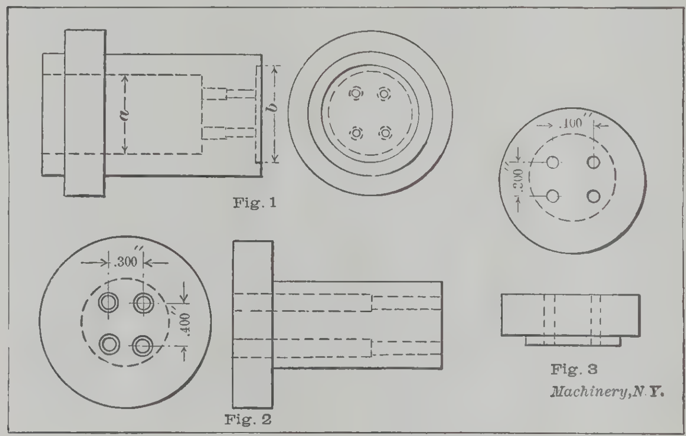
* * *

MACHINE SHOP PRACTICE*

JIG AND DIE WORK IN THE BENCH LATHE - 2

A. L. MONRAD†

Those who read the first installment of this article in the November number will recall that the method of making two small jigs to be used in connection with drilling four holes in the die shown in Fig. 1 was explained. We shall now consider the drilling of this hardened die with a hollow diamond drill, and also the way in which the holes are ground in a bench lathe. Of course, drilling into hardened steel is a



Figs. 1, 2 and 3. Die and Jigs for Drilling

very unusual operation. It was resorted to in this case because of changes in the die, which made it necessary to either drill holes or make a new die. As less time would be required for drilling, this was done, and while the operation is one rarely performed, it will doubtless be of interest to those not familiar with it.

It was first necessary to locate the jigs (shown in Figs. 2 and 3), which had been previously fitted to the die, so that the holes in each jig were in alignment. This was accomplished as follows: First, the jigs were placed in each end of the die which rested in a V-block, one being in hole a and the other in recess b. This block, in turn, was on an accurate surface plate. Two close-fitting plugs were next inserted in the two upper holes in each jig, and these plugs were then tested with a surface gage until they were all parallel with the surface plate, the necesssary adjustments being made, of course, by turning the jigs with relation to the die. When the jigs were correctly set, they were clamped together and then fastened to the die temporarily with a little solder, after which the clamp was removed.

The drilling was done in a sensitive drill press. The die with the attached jigs is shown on the drill press table in Fig. 2. As the work was hardened, the drilling operation was performed with a hollow drill D, the end of which was charged with number 4 diamond dust and number 80 alundum. The drill was first charged with diamond dust mixed in sperm oil, by having the diamond on a hardened and ground parallel block and by dropping the drill onto it about a dozen times by a movement of the handle A. This pounded the diamond into the end of the drill. While the drill was being charged, the drill press remained stationary. The drilling operation was performed by dropping a little alundum and then a drop of sperm oil in the hole, and pounding the drill, which was run at a high speed, against the work. The drill was recharged with diamond about every ten minutes. The large or counterbored part of the holes was first drilled to the proper depth with jig B guiding the drill. The work was then inverted and the small part of each hole drilled in until it met the larger part, when the small plug E in the center dropped down and left a clean counterbored hole.

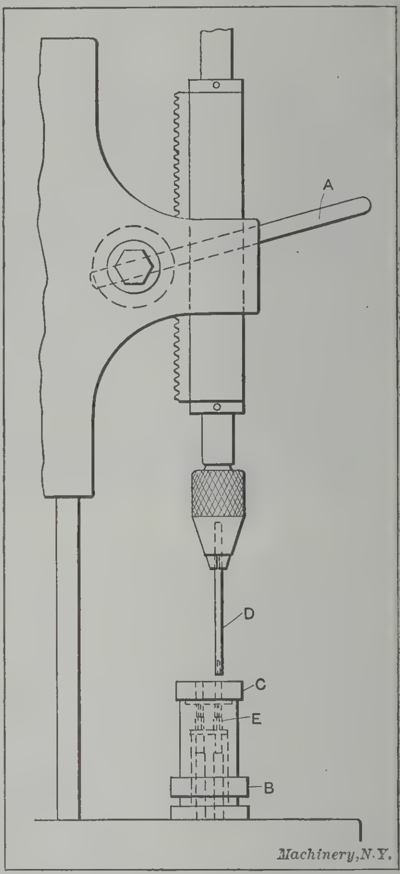


Fig. 4. Sensitive Drill Press with Hollow Diamond Drill and Work in Place

As the hollow drill will cut a hole a little large, it was made 0.010 inch smaller than the diameter of the small holes (which were 0.052 inch) and this gave sufficient allowance for grinding in the bench lathe, which was the next operation performed. The master-plate M with the brass disk G attached to it was strapped to the face-plate F with the locating plug in the spindle inserted in the central hole in the master plate. A recess was then turned in disk G to fit the end of the die as shown in Fig. 5. The die was then inserted in this disk and located so that the four holes in it were approximately in alignment with those in the master-plate. The die was then soldered to disk G, which, it will be remembered, was provided with elongated slots for the clamping screws. A diamond lap was used when grinding the small holes. This lap N was made of tool steel and was charged with number 2 diamond dust and sperm oil by being rolled between two hardened and ground blocks.

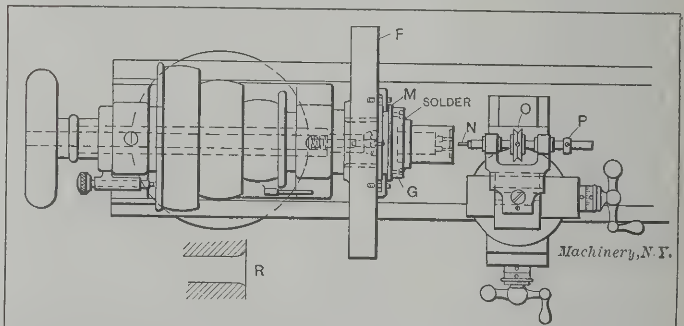


Fig. 5. Finishing the Hole in a Bench Lathe with a Diamond Lap

When grinding holes in this way, the lap should run at the highest speed that can be obtained and the die at the slowest. The feed may be obtained by placing the forefinger and thumb on the sides of the wheel O and pushing the grinder spindle back and forth at a moderate speed. Care should be taken to prevent the ends of the holes in the die from being ground "bell-mouthed," that is, rounding at the end as shown enlarged at R. This will not occur if the stop P and the wheel O are located so that the lap cannot move clear of the hole. It will be seen that if the lap were to leave the hole at the end of the stroke, there would be more or less springing action on the part of the lap, which, when it entered the work on the return stroke, would tend to grind the end of the hole rounding.

* With Shop Operation Sheet Supplement.
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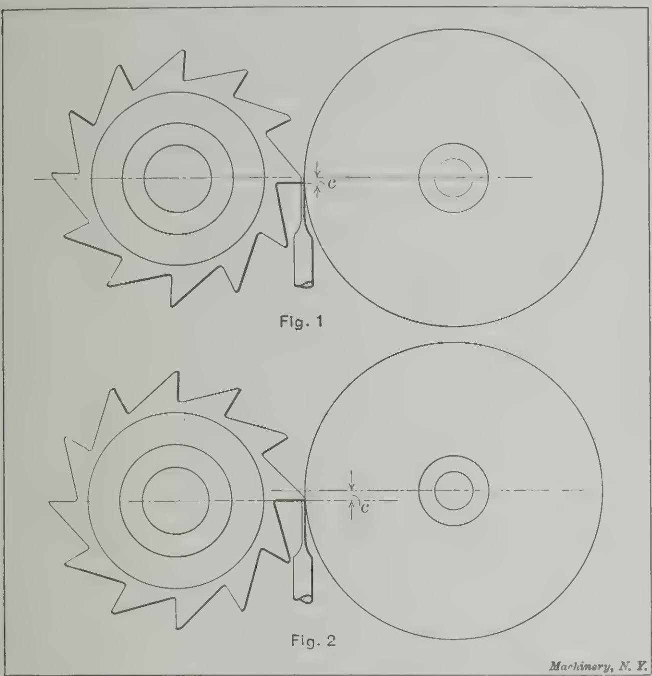
ERRORS IN GRINDING TAPERED REAMERS AND MILLING CUTTERS

H. A. S. HOWARTH*

There are two distinct methods that are commonly used for grinding the clearance on reamers and milling cutters. These methods involve the relative positions of the axis of the reamer, the grinding wheel spindle, and the guide finger. The first method is shown in Fig. 1, with the axes of the reamer and the wheel spindle in the same horizontal plane. The



Figs. 1 and 2. Common Methods used for Grinding Clearance on Reamers and Milling Cutters

finger is set so that the cutting edge of the reamer lies at sufficient distance below this plane to give proper clearance or backing off. The amount of clearance is decreased by raising and increased by lowering the finger.

The second method is shown in Fig. 2 with the axis of the reamer in the same horizontal plane with the cutting edge, *i. e.*, with the end of the guide finger; but the wheel spindle is above this plane a variable amount governed by the clearance desired. As the wheel is raised the clearance is increased and *vice versa.* Cylindrical reamers or cutters can be accurately ground by either of these methods, whether the flutes are straight or spiral; but tapered reamers or cutters *cannot* be ground accurately by the first method; they *can,*

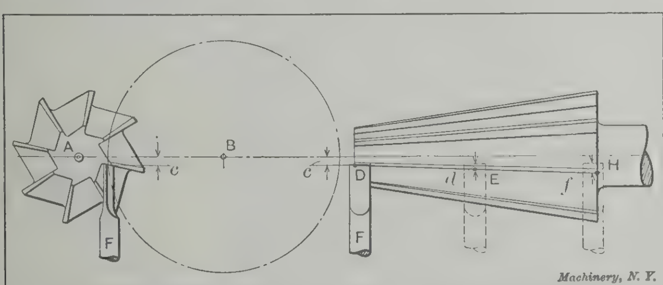


Fig. 3. Illustration showing Conditions when Grinding a Taper Reamer by Method shown in Fig. 1

however, be so ground by the second method. Because of the extensive use of the first method it is the purpose of this article to prove its inaccuracy and to discuss the errors introduced in grinding tapered reamers and cutters. The actual error will be calculated for a number of sizes and the reader can then form some idea of the probable error in cases under his observation.

By reference to Fig. 3, it will be clearly seen what takes place when a tapered reamer is ground by the method in Fig. 1. The finger F is set at a distance c below the plane of centers AB, and, being fastened to the frame of the grinder, it does not change its position relative to the wheel. The reamer, mounted on centers, is moved back and forth in front of the wheel with its cutting face resting on the finger. When the wheel is grinding at the small end, the cutting edge at point D rests on the finger a distance c below AB; but the points E and H on the same cutting edge are lower down by distances d and f, respectively. This is due to the conical form of the reamer. When the point E reaches the wheel and finger, it has been lifted the distance d and is ground also at distance c below plane AB. The same thing is true of the point H. It seems on the face of it that this method would produce a truly conical reamer. Hence it is that so many have fallen into the error of using it. However, by a formula which is derived below, the error is seen to be considerable in some cases while negligible in others.

The construction from which the formula is derived is shown in Fig. 4, which represents the method shown in Fig. 1. The end D of the finger is snown at a distance $GD = c$ below the horizontal plane of the axes of the reamer and the spindle. The end view shows a heavy line AHK which represents the cutting edge actually ground by this method.

Suppose the exact diameters of the ends of the reamer are known; A is a point on the circumference at the small end while K is a corresponding point on the large end. In setting up for grinding, the centers are set over so that as the edge AHK passes over the finger, the wheel will grind OA and OK to the proper radii. When A rests on the point of the finger, H and K will be below it, as shown; but as H reaches the finger A passes above it, and K still remains below it. Finally when K reaches the finger, the whole cutting edge except point K will be above it, and nearer the horizontal plane of the reamer axis.

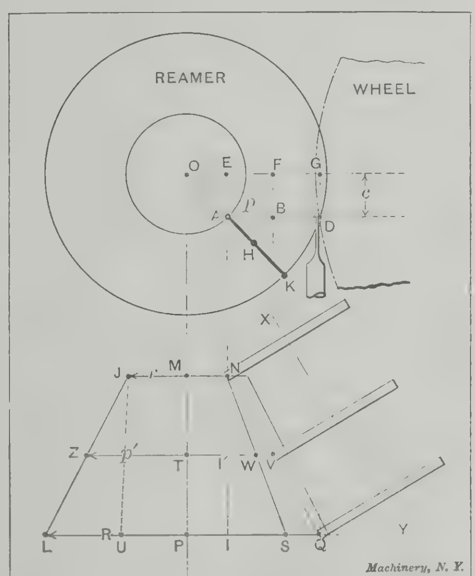


Fig. 4. Diagram for Calculating the Error Involved when grinding a Taper Reamer by Method shown in Fig. 1.

In order better to understand what takes place, the line XY, which represents the wheel spindle axis, is shown in the bottom view. The wheel is shown in three positions. The points N, V and Q are bottom views of the points ground in the three positions shown. These points will lie in a straight line, parallel to XY, and at distance c below the horizontal plane of the centers. This line NVQ is the line ABD in the end view. All points of the cutting edge AHK swing up into this line ABD to be ground. Since NWS is the bottom view of AHK, all of its points swing over into the line NVQ.

Let a point W be taken at a perpendicular distance MT below the end of the reamer so that $\frac{MT}{MP} = m$ which can have any value from zero to one. When W is ground, it is at point V and we have the further geometric relation that

$$\frac{TV - MN}{PQ - MN} = \frac{MT}{MP} = m \qquad (1)$$

This is taken from the triangles NIQ and $NI'W$. Taking now the equivalents of TV, MN, and PQ in the end view we have $TV = OF$, $MN = OE$, $PQ = OG$. By substituting these values in Equation (1) we have

$$\frac{OG - OE}{OF - OE} = m \qquad (2)$$

It is from this equation that we must get the value of the radius $OH = OB = p$, which will be the actual radius ground

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by the wheel at W. Let $OA = r$, and $OK = R$, being, respectively, the radii of the small and large ends of the reamer. Then from Equation (2) OF is solved and squared as follows:

$$OF = m\,(OG - OE) + OE$$

$$OF^2 = [m\,(OG - OE) + OE]^2$$

$$p = \sqrt{(OF^2 + FB^2)}$$

$$FB^2 = c^2,\ OG = \sqrt{(R^2 - c^2)},\ OE = \sqrt{(r^2 - c^2)}.$$

Then by substituting in (3) and simplifying we have the following value:

$$p = \sqrt{\{m^2\,[R^2 + r^2 - 2c^2 - 2\sqrt{(R^2 - c^2)\,(r^2 - c^2)}\,] - 2m\,[r^2 - c^2 - \sqrt{(R^2 - c^2)\,(r^2 - c^2)}\,] + r^2\}} \quad (4)$$

While the above equation gives the value of p actually ground, it is necessary for us to know what the value should be if the point W were on a true cone. This is shown by the

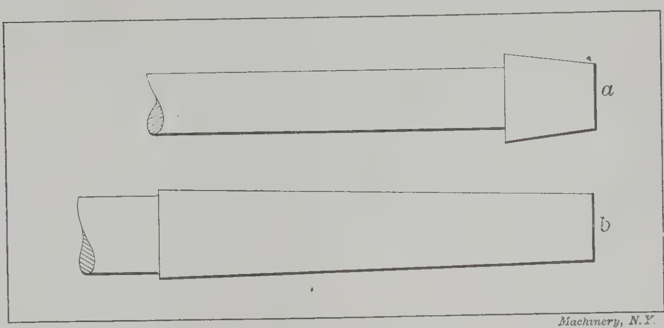


Fig. 5. Taper Reamers of Proportions given in Example 1

line ZT. The point Z is on an element of the cone and at a distance MT below the small end of the reamer. Hence we have the proportion following:

$$\frac{ZT - JM}{LP - JM} = \frac{MT}{MP} = m \quad (5)$$

ZT is our true radius which we will call p', while $JM = r$ and $LP = R$. Then by rearrangement and substitution we have

$$p' = r + m\,(R - r) \quad (6)$$

The error which we are seeking will be the difference between p and p'. Hence

$p' - p =$ error in radius.

$2\,(p' - p) =$ error in diameter.

The error will vary in amount from zero at either end to a maximum near the middle of the cutting edge. Hence m may be assumed at some value such as 0.4 or 0.5.

Example 1.—Take a reamer whose diameters are 1 inch and 1.2 inch at the small and large ends, respectively. Then $R = 0.6$ and $r = 0.5$ inch. We will assume in our calculations that c is one-fifth of r. Hence $c = 0.1$ inch. Then m will be taken at different values in order to show about what it should be in this case. The errors in diameters will be as follows:

m	$2\,(p' - p)$
0.35	0.000152
0.40	0.000154
0.45	0.000157
0.50	0.000157

It is evident that the greatest error in this case occurs when m is about 0.5. This is so because the taper is slight compared with the diameters. This also accounts for the very small error, which is a little over one and one-half ten-thousandths inch. Fig. 5 shows two reamers a and b, which have the proportions used above. The length of the flutes does not influence the result, because it does not appear in the formulas. The error depends on the value of the ratio $\frac{R}{r}$ and on the size of r.

Example 2.—Take the smallest or No. 1 B. & S. reamer; $r = 0.1$, $R = 0.16$, $c = 0.02$ inch; $m = 0.4$. Error in diameter is 0.000054 inch, which is very small.

Because the error in the above cases is relatively insignificant, it is not to be supposed that it is negligible in all instances. The following examples show errors of from 0.002 inch to 0.011 inch.

Example 3.—$R = 1.0$, $r = 0.5$, $c = 0.1$, $m = 0.4$.

Error in diameter is 0.00176 inch.

Example 4.—$R = 1.5$, $r = 0.5$, $c = 0.1$, $m = 0.4$.

Error in diameter is 0.00355 inch.

Example 5.—Use the same values as in Example 3, but give greater clearance by increasing the value of c to 0.15. Then $R = 1.0$, $r = 0.5$, $c = 0.15$, $m = 0.4$.

Error in diameter is 0.00408 inch, *i. e.*, more than twice as great as the error in Example 3. This shows how great an effect the amount of clearance has on the error.

Now assume some sizes that would be typical of milling cutters.

Example 6.—Use a value of c that is less than one-fifth of r, say about one-seventh. $R = 3$, $r = 2$, $c = 0.3$, $m = 0.4$. Error in diameter is 0.0016 inch which is smaller than expected because of the reduced ratio of r to c.

Example 7.—$R = 4$, $r = 2$, $c = 0.4$, $m = 0.4$.

Error in diameter is 0.00704 inch, which is four times the error in Example 3. This was to be expected because the dimensions were taken four times as great.

Example 8.—Take the same sizes as in Example 7 except increase the clearance by making $c = 0.5$ inch instead of 0.4.

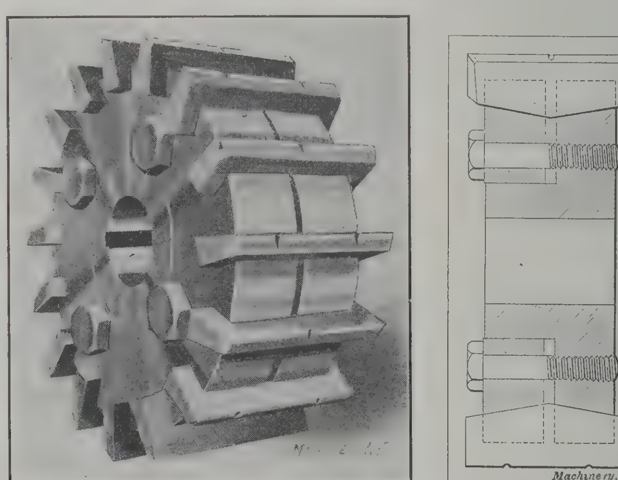
Error in diameter is 0.0112 inch.

The errors shown above will explain many things that happen in connection with the making and the use of tapered reamers and milling cutters. Many persons have probably noticed that when grinding the clearance on a new tapered reamer or cutter the center will come up sharp before the ends do. The reason for this is now plain. When fitting an arbor into a tapered hole it seems frequently to bear hard in the middle. This may be due to the reaming of the hole in the first place by an improperly ground reamer. It is difficult even with a perfect reamer to avoid reaming the ends of the hole larger than the reamer itself. Hence any inaccuracy will tend to increase the trouble. The conclusion from the above discussion is obvious. Tapered reamers and milling cutters should be ground by the method shown in Fig. 2, *i. e.*, with the cutting edge and the point of the finger in the horizontal plane of the axis of the reamer. Then the proper amount of clearance can be obtained by lowering the reamer and finger together, or by raising the wheel.

* * *

MILLING CUTTER WITH INSERTED TEETH

An inserted tooth milling cutter of a design radically different from those commonly in use has been brought out by Messrs. Modes Eadon & Sons, Ltd., of President Works, Sheffield, England. The body of the cutter is made in two parts



Figs. 1 and 2. Inserted-tooth Milling Cutter of English Design

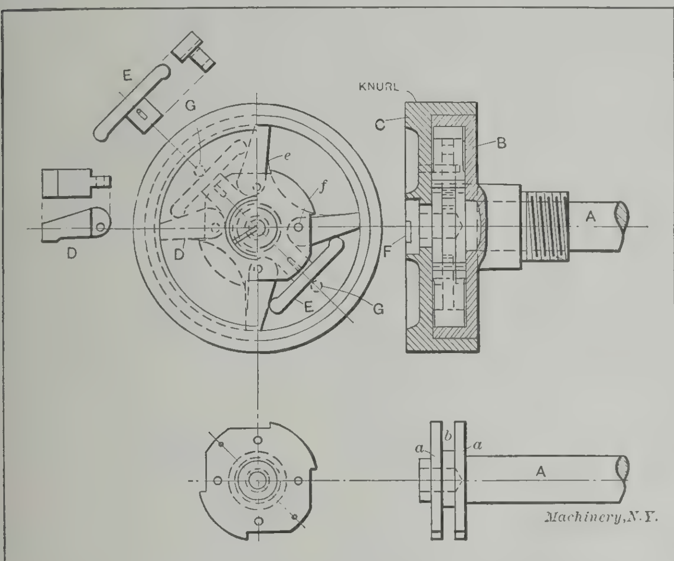
as shown in the accompanying illustrations, the two parts being drawn together either by a central nut, or, preferably, by a number of screws. The teeth are made of dove-tail section, and the bottom of the tooth is made of a V-shape as shown in the line-engraving. The body, of course, is slotted to fit this shape of the teeth. When the teeth are placed in position and the two halves of the cutter body drawn together, the teeth are forced tightly into the upper portions of the dove-tail, thus providing for an extremely firm hold of the cutter teeth. Being held by a wedge grip in two directions, it is evident that any movement whatever is impossible. It is claimed that a single tooth cannot become loose, and that breakage of one tooth does not loosen the other teeth.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

LOCKING DEVICE FOR ADJUSTING SCREWS

An automatic locking device is shown in the accompanying sketch, which is constructed as follows: Part A is the screw or shaft to be held rigid at any point that may be required. The hub parts a are turned solid on the shaft and far enough from the end to allow a bearing for the wheel C. The slot b is cut deep enough so that the lugs on pawls D and the pawl-releasing bars E have sufficient clearance to work freely. The pawls should be put in position as shown in the assembled view, and held rigidly while turning them to the inside diam-



A Device for Locking an Adjusting Screw in any Position

eter of the friction cup B; they are then relieved at the shoulders until their face edges come back almost on a line with the center, when the friction cup is removed. This friction cup is screwed or bolted to the casting carrying the shaft; the parts are then assembled. The pawls D are held in place by pins f and are forced outward by springs e. The pawl releasing-bars are put in position as shown, and the shaft is put in place with the releasing wheel C mounted on the end and secured by a screw F adjusted to allow the wheel to work freely. The pins G of the releasing wheel are in contact with the pawl-releasing bars E. By turning the wheel either to the right or left, these pins force the releasing bars inward, bringing the pawls away from the walls of the friction cup; the shaft is then readily moved in the required direction. It will be seen that when the wheel is released the springs e will force the pawls outward against the walls of the friction cup, and any attempt to turn the shaft will meet with a stubborn resistance at these points of contact. This little wheel is thoroughly practical and it relieves one of the dread of having an adjustment altered by the jarring of a machine.

Baltimore, Md. ROBERT O'NEAL.

MAKING PRESS FITS

Making a press fit is looked upon by a great many machinists as a very difficult job, and undoubtedly this is true in cases where the machinist has no micrometer calipers and depends entirely upon his sense of feeling. Without the micrometer, it is impossible to know just what has been allowed in difference between the diameter of the plug and hole, and, consequently, the pressure required to force in the plug cannot be even approximately ascertained. Of course in manufacturing shops where one man does all the press fitting, does it continually, and calipers with gages made by the tool-maker, with the allowance calculated for him, he cannot be expected to do other than a good job. On the other hand, in contract or repair shops it is too expensive to make gages, as the jobs vary too often; consequently, making a press fit in such shops requires considerable skill.

It is only necessary to use an inside caliper with micrometer adjustment for this work, as this tool may first be set to the exact size of the bore and then to the required number of thousandths larger than the bore. A regular pair of outside calipers may then be set to the inside caliper. I have kept a record of press fits recording the kind of metal, allowance, area of fitting, and the pressure required to force the plug in the hole. This record has proved valuable to refer to when making press fits, but the handiest and most accurate data I have found is that given in MACHINERY'S Data Sheet for August, 1903. I have used this Data Sheet for some time, and find it to be so accurate that I can place absolute confidence in it; thereby removing that lump in my chest that used to settle there every time I made a press fit. If you want to do good work, buy or borrow a good inside micrometer caliper of good make, get this Data Sheet, study it until you understand it thoroughly, and you will soon be up-to-date. By taking the formula $P = \frac{A D (P F)}{2}$ and transposing it thus $D = \frac{2 P}{A (P F)}$ the allowance when the number of tons pressure is known, is easily determined. In these formulas,

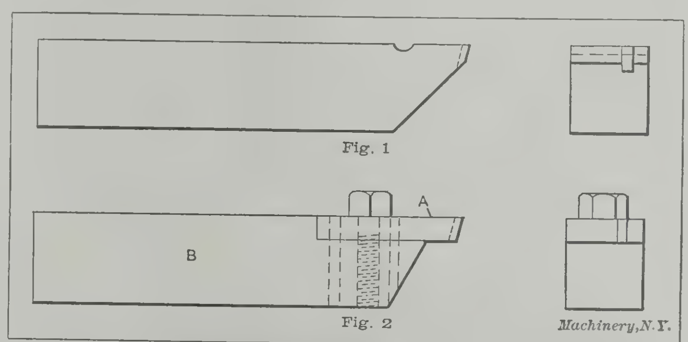
P = pressure required in tons,
D = difference in diameter between plug and bore,
$P F$ = pressure factor taken from Data Sheet,
A = area of fitting in square inches.

By using the last formula, and then calipering as described, one will be surprised at the accurate results obtained. A good lubricant to use when pressing the plug into a hole, consists of white lead and machine oil, just enough of the oil being added to make a paste of about twice the consistency of paint.

Augusta, Ga. J. S. VAN PELT.

MASTER FORM TOOLS

The extensive use of circular forming tools, brought about by the introduction of the automatic screw machine, has led to more or less experimenting to obtain an inexpensive method of making the master tools with which the tool used to form the circular cutter is made. In some shops this tool is made



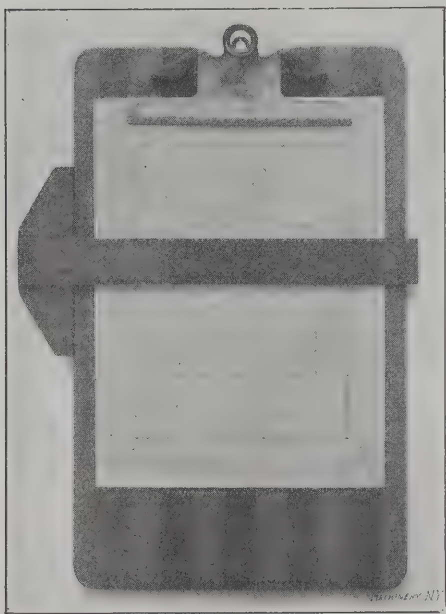
Master Tools for Making Circular Cutters

in the shape shown in Fig. 1, being a solid bar of steel. The outline is laid out on the cutting end and the tool is milled out and finished by filing. This type of tool is often annealed and recut for other forms after the completion of the forming tool. The blanks, of different widths desired, are carried in stock ready for use, and a minimum amount of labor is left for the form-tool maker, as the roughing out is all done with cheaper help. In other shops the master tool is always saved and filed away, in a cabinet, with the form tool, and when this is the case the design shown in Fig. 2 is superior because it occupies less space than Fig. 1, and it is also much easier and less costly to make. In Fig. 2, A is the tool proper which is fastened to the holder B by a hexagon head screw and two dowel pins. Both screw hole and dowel pin holes are drilled and reamed in a simple jig, so as to get the correct location from the back edge of the tool. In making these tools, much costly experimenting has led to the

adoption of "Intra" steel for the master tool, while the circular tool is made from several different brands of high-speed steel, depending on the material to be operated on and other considerations. F. CHAS. SCRIBNER.

Greenfield, Mass.

CONVENIENT DRAWING OUTFIT



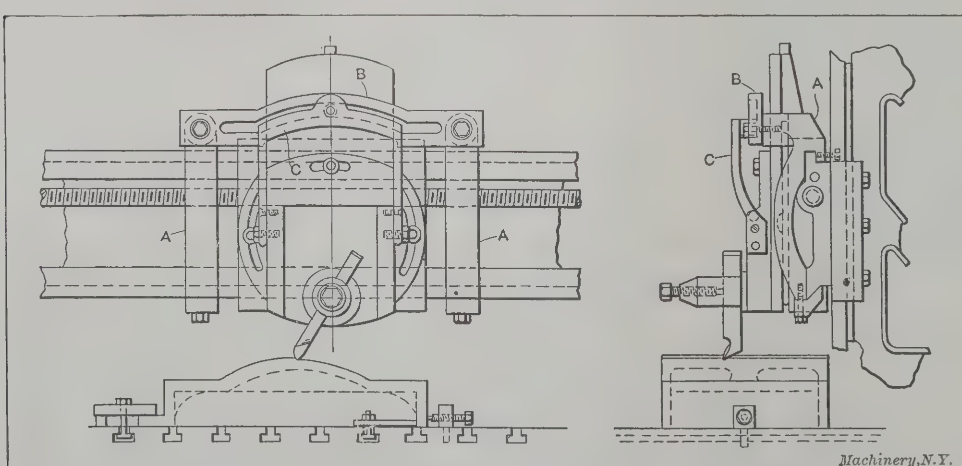
Filing Board used for Drawing

A very convenient drawing outfit for making sketches on small sheets of paper or calculating sheets, that has recently come into quite extensive use, is shown in the accompanying engraving. The outfit consists of an ordinary letter filing board, the left-hand edge of which is planed true, and a small T-square, both of which may be obtained in any stationery or drawing material store. The drawing paper is held by the spring clip as shown. MARTIN JOACHIMSON.

New York City.

PLANER ATTACHMENT FOR MACHINING CURVED SURFACES

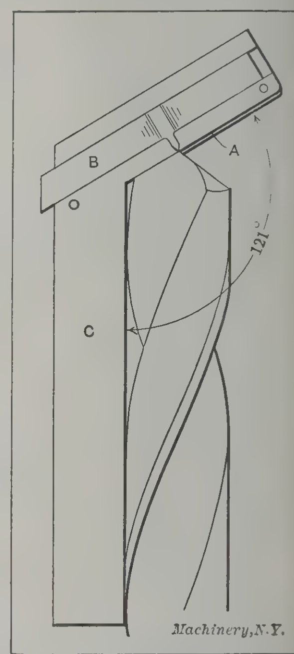
An attachment for planing work of a convex or concave shape is shown in the accompanying engraving. The attachment consists of four parts all of which are of cast iron. These castings comprise the two side pieces or brackets *A*, the templet *B*, and the double-armed "leader" *C*, which is attached to the tool slide. Of course, different templets have to be used for different jobs, the shape of each being governed by the special requirements of the work in hand. The side brackets must be cast with bosses to allow the templet to clear the planer head, so that the latter can move along the rail. As shown, the brackets fit over the top guide on the rail and any slack is taken up by the set-screw shown in the end view. Separate pieces are fitted to the bottom of each bracket which are put in place after the fixture is put on the rail. These brackets are at all times stationary. The templet is worked out on a profiler or slotter, and it is attached to the brackets *A* by bolts. It should be machined carefully to the required shape, for, obviously, when it is made it will produce any number of pieces which will be exact duplicates. Attached to the double-armed leader *C* is a stud upon which is mounted a loose sleeve which travels in, and fits the slot of the templet. As the head is driven along the rail the tool is automatically raised or lowered according to the formation of the guiding slot in the templet. Of course, when this attachment is in use, the screw of the slide is removed. The fixture is entirely automatic, and when it is in use the cross-feed may be put on, and the planer will take care of the work. This fixture is not new, but there are doubtless many who are not familiar with it. J. B. M.



Planer Attachment which automatically guides the Tool when machining Curved Surfaces

GAGE FOR DRILL GRINDING

A gage to be used when grinding either flat or twist drills, in order to obtain the proper lip and clearance angles as well as equal lengths for the cutting edges, is shown in the accompanying line engraving. This gage is a great deal handier and more convenient to use than a protractor and scale, and, besides, it can be carried in the pocket. The surface *A* of the head forms an angle of 121 degrees with the shank *C*, which gives a lip angle to the drill of 59 degrees. Fitted to the head is a piece *B*, which slides in a dove-tailed slot and which has attached to it a pointer, as shown, which is used for measuring the lengths of the cutting edges. This is accomplished by setting the pointer as shown in the illustration, and then without moving it, turning the drill over so that the length of the other cutting edge may be measured. If the lengths of the cutting edges are unequal, the short one is, of course, ground off until the pointer coincides with the upper end of each edge. The surface *A* of the gage is beveled to an angle of 12 degrees so that the clearance angle may be tested when the drill is being ground.



Drill Gage for Testing the Lip and Clearance Angles and the Lengths of the Cutting Edges

Lestershire, N. Y. L. B. MINGES.

MILLING FLUTES IN REAMERS WITH IRREGULAR WIDTHS AND DEPTHS

For the purpose of eliminating the chatter marks sometimes found in holes finished with reamers having equally spaced teeth, a good method is adopted by most reamer manufacturers, which is perhaps known to all reamer users, of making flutes of irregular widths and depths. Having had the opportunity to cut reamers of this type, I have tried the following method which has proved quite satisfactory.

Suppose we want to cut a reamer with 6, 8, 10, 12, or any regular number of teeth. Knowing, as we do, that a circumference contains 360 degrees, and bearing in mind that opposite teeth are to be cut to the same depth (to facilitate measuring), it will readily be understood that instead of dividing 360 degrees into irregular spaces, we divide 180 degrees into one-half as many spaces as flutes required. Let us take for example a reamer to have 12 flutes; this gives us 180 degrees to be divided into six irregular spaces. We first divide 180 degrees by 6, obtaining 30 degrees, which would be the angular distance between the teeth for regular spacing. In order to get irregular spaces we must find six numbers that will total 180. In this case, we

have 26, 28, 30, 31, 32, and 33 degrees. The next move is to transfer the degrees to turns and holes for indexing. Nearly all milling machine dividing heads have worm-wheels of 40 teeth, making 40 turns equal 360 degrees or one revolution. This will make one turn equal 9 degrees, and by using a 27-hole circle, 3 holes will equal one degree. Going back to our irregular divisions, we first come to 26 degrees. It is not necessary to index for the first cut. The indexing for the remaining divisions is found as follows:

28 degrees ÷ 9 degrees = 3 1/9 = 3 turns and 3 holes
30 degrees ÷ 9 degrees = 3 3/9 = 3 turns and 9 holes
31 degrees ÷ 9 degrees = 3 4/9 = 3 turns and 12 holes
32 degrees ÷ 9 degrees = 3 5/9 = 3 turns and 15 holes
33 degrees ÷ 9 degrees = 3 6/9 = 3 turns and 18 holes

Having the degrees changed to turns and parts of a turn for the indexing crank, we now go ahead with the first cut, being careful not to go too deep, so that the required width of land can be obtained. It will now be seen that as the angle between the teeth changes, the depth must also be changed if the lands are to be made uniform. This depth is found more readily by practice than by figures. When large reamers are to be cut, instead of dividing 180 degrees, 90 degrees may be used, and in that case four teeth instead of two can be cut to the same depth. JAMES FRASER.

New Haven, Conn.

REMOVING BROKEN DEEP-WELL PUMP-ROD

An A. D. Cook deep-well pump-rod separated far down in the casing, part being pulled out at the top and the remainder staying at the bottom. In order to secure the lower part, a

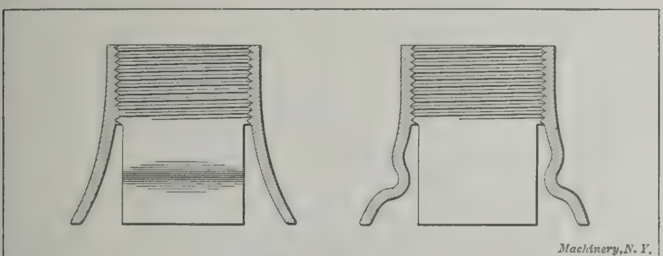


Fig. 1. Special Sleeve for Gripping the End of the Broken Rod

piece of iron pipe was split at one end into four leaves, as shown in Fig. 1, and the solid end tapped out and bushed down to fit the thread upon the pump-rod taken out. Two of these leaves were beaded to form a snap hook after all four of them had been bent out at the lower end to completely fill the well casing. These two beaded leaves were intended to form a hook smaller than the upper head of the lost pump-rod C (Fig. 2), so that when part B was lowered into the casing and forced down over the upper end of C, the leaves would spring back over the shoulder and grip the rod C, thereby enabling it to be pulled out. The device worked very satisfactorily. It was attached to the lower end of the upper section A of the broken pump-rod and lowered until C was gripped.

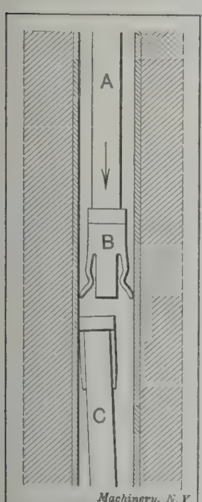
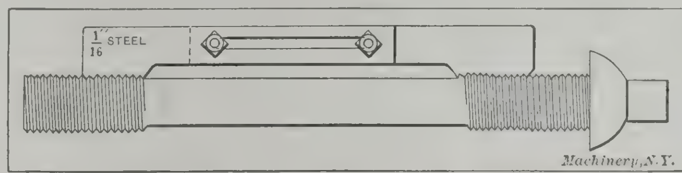


Fig. 2. Method of Removing Broken Pump-rod

Wadsworth, Ohio. HOWARD D. YODER.

THREAD GAGE FOR STAY-BOLTS

Radial stays are a hard thing to fit into place, according to some boilermakers, because the threads in the boiler plates and the threads on the stay-bolt will not mesh in both sheets at the same time. I knew of one case where a boilermaker spent two days putting in five stays, and these were obtained by sorting over about one hundred stay-bolts. Schemes are tried of having the tap so made that the threads in both plates will be as on a continuous rod, and this helps a lot; in fact, it is necessary to have the holes exactly in line. But another trouble often comes from the fact that the stay-bolts are turned up in a lathe which is so worn that in a foot or two of length the pitch is a little off which changes the position of the threads so that they cross when the bolt is screwed into place in the boiler plates. It will pass through the outside sheet all right, but will not fit into the inner sheet. Now if



Thread Gage applied to a Stay-bolt

this stay-bolt is lengthened a little, by hammering, so that the threads are moved a little ahead until they will exactly fit into the threads of both sheets, everything works smoothly.

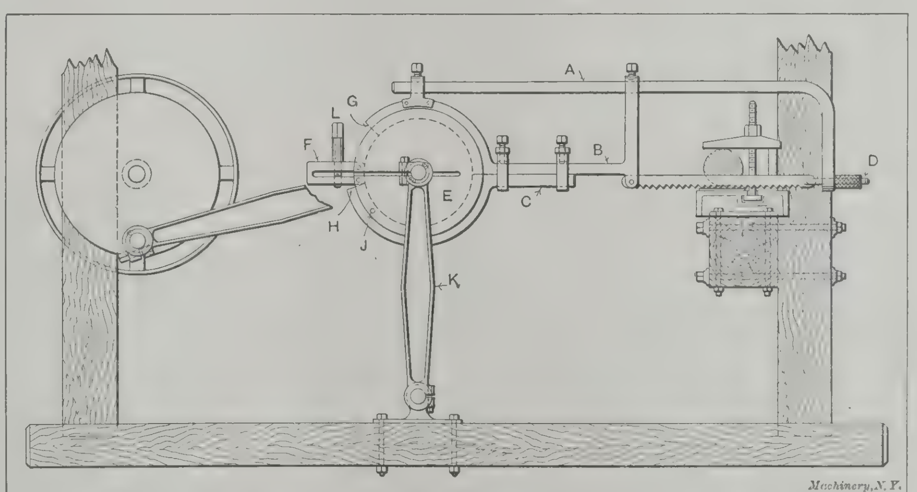
The illustration shows an adjustable gage that can be used in spacing these threads. This gage can be set by the tap that was used in making the threads in the plates, or it can even be placed in the holes and set to the actual threads in the sheets. Then the bolts can be drawn out with a hammer to fit the gage, and a lot of hard work will be eliminated.

Two Harbors, Minn. A. G. JOHNSON.

MULTIPLE POWER-DRIVEN HACK-SAW

Old, rejected street car axles were being cut into short lengths to be used for drop-forging stock, and other purposes for which this steel is suitable, but the work of sawing them on a single reciprocating saw proved too slow. A gang saw, a view of which is shown in the accompanying engraving, was built, which will cut simultaneously the whole length of an axle into any number of pieces required. The construction of the saw is simple, yet it is rigid, and will stand up under very heavy sawing.

The saw frame is composed of three pieces, A, B and C. The first is a machine steel bar 1¼ inch in diameter, the end of which is enlarged to receive an adjusting screw D. The two halves, B and C of the remainder of the frame are hand-forged from machine steel stock 1½ inch wide and ½ inch



Elevation of a Multiple Hack-saw for Sawing Stock into a Number of Lengths, simultaneously

thick. The vertical part of B is slotted at the lower end to receive the saw, and the upper end is enlarged to provide for a hole through which passes bar A. The circular ends of B and C fit into a groove which is turned in the circumference of the cast-iron disk E 10 inches in diameter. To allow clamping this disk in any position on the shaft, a slot is milled partway through it as shown, and also in the clamping block F, which is attached by pins, to the disk on each side of the slot. It will be noted that the end of the saw frame is not a complete circle, as it terminates at G and H. This serves two purposes: After the saw has finished its cut, the end H

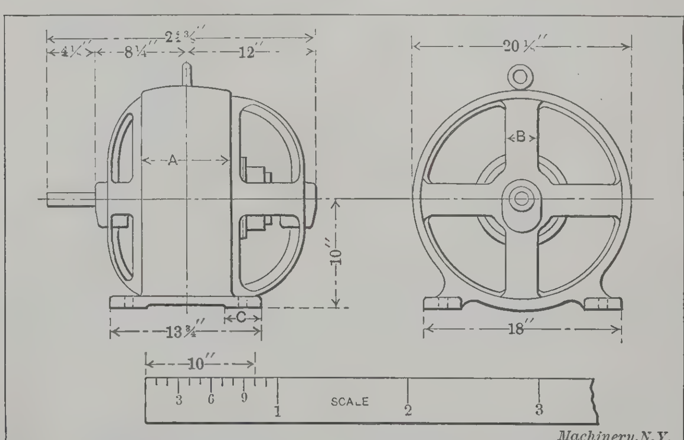
prevents it from cutting into the chucking table, by coming in contact with stop *F*, while the space between end *G* and the stop permits lifting the saw to take in any stock within the capacity of the machine. When it is desired to put one or more saws out of service, the frame is raised until the end *H* drops down past the hole *J* through which a stop-pin is inserted, thus securing the frame in an elevated position. The shaft upon which the disks are mounted, is turned down at each end to receive the vertical supporting rods *K* and also the connecting-rods. The latter are connected to the two crank disks mounted on either end of the driving shaft, which runs in bearings attached to wooden uprights. At the opposite end of the frame there are other uprights across which is secured a timber to which is attached a cast-iron plate with a T-slot which permits strapping down the stock at any place along the table. Any of the saw frames can be removed from their disk in five minutes, or replaced in the same time, and pieces of any length may be cut by simply shifting the disks to the proper position on the shaft. A key in the shaft prevents the disks from turning, and when they are properly located they are clamped by the screw *L*.

In forging the circular parts of the frame they are first formed as near the required shape as possible. After machining the joints between the two halves they are held together by the clamps shown, and the circular ends are tested on a surface plate, to see that the sides are flat, and that the vertical part of *B* is in a plane parallel with them. These ends can be faced on a disk grinder; if available, a double disk grinder is preferable. Just enough stock is removed to give a fair amount of trued surface. If no other means is at hand the inside of the strap can be machined in the drill press. By fitting the groove in the disk *E* to the strap, the latter may be ground without reference to any particular width. With a machine of this type it is possible to saw a number of pieces in about the same time as required for one; and obviously, the machine may be designed for any desired number of saws.

M. E. DAWSON.

A KINK FOR DRAFTSMEN

Very often a draftsman in laying out work, finds that he has to refer to outline drawings in catalogues where not enough dimensions are given to make a drawing from and have it to any kind of scale.



Catalogue Drawing and Scale for Measuring Details

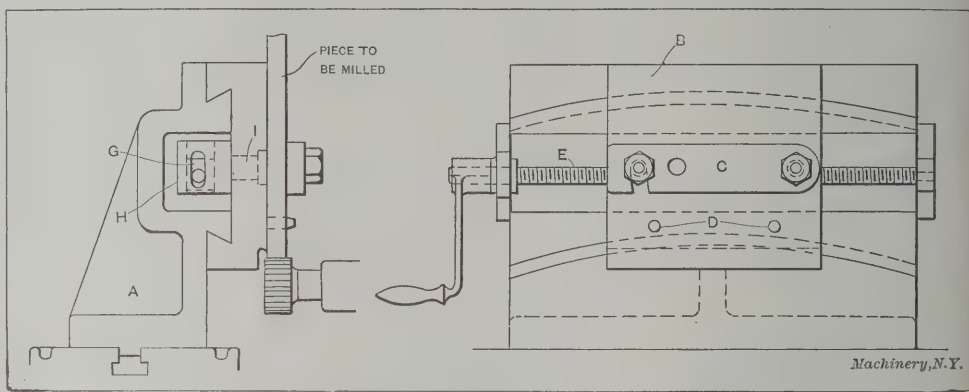
When a drawing of this kind is to be made, as for example a drawing of the motor shown in the engraving, the dimensions of which are insufficient to make a drawing from, take a piece of paper with a straight-edge and mark off a distance, say from the base to the center of the shaft which represents, in this case, 10 inches. Then divide this space into ten equal parts and carry it on two parts more which represents one foot on the catalogue engraving. Each part of this space represents one inch, and each division may be subdivided as required. The scale may be made any length by stepping off spaces equal to one foot, as shown in the engraving. By using such a scale, the dimensions of *A*, *B*, *C*, etc., may be easily found.

This is a very simple method and one which I find helps a great deal at times. A new scale has to be made for each different engraving, the proper proportions being obtained from some one of the dimensions given.

New Haven, Conn. J. H. SCHULTHEISS.

MILLING ATTACHMENT FOR MACHINING A CURVE OF LARGE RADIUS

Some time ago we had a large quantity of parts that had a finished surface on a radius of about five feet, and this surface had to be an exact distance from two holes in the piece. The radius was far too large for any lathe we had available, but the length of the surface to be finished was only a few



Milling Attachment for Machining a Curve of Large Radius

inches, so the device shown in the accompanying engraving was made. An angle casting *A* was made with a dovetail slide of suitable radius, to which a sliding block *B* was fitted. A feed-screw *E* engaged with a nut *G* attached to the back of *B*. To allow for the variations in height and angle as *B* moved across on the curved slide, the nut *G* could slide up and down in a slot in holder *H*, and *H* could swivel on its axle *I*. Two pins were put in block *B* in the proper position to take the holes in the piece to be milled, and a clamp-bar *C* arranged to hold the work in place. The attachment was put on a milling machine and the table adjusted vertically until the cutter was at the proper height. It worked satisfactorily, and we were able to make good time on what had been a troublesome job.

W. ALTON.

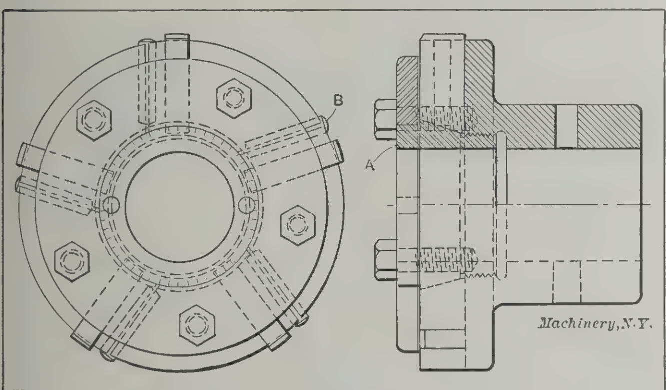
HOW WE GOT ELECTRIC LIGHTS

The shop where I learned the trade was a small one, and although the place was turning out a very good class of work and considerable of it, the "boss" was rather inclined to be a bit slow in putting in improvements for the benefit of the workmen. One of the improvements needed was electric lights, and many were the cuss-words which were fired at the measly old gas jets which were always in the wrong place and never gave sufficient light. One dark, dismal day one of the boys was working at the bench, and he had the gas jet down near the vise; he felt a warm sensation around the top of his head and when he put his hand up to find out what the trouble was he found that his cap and a good share of his "thatch" had gone up in smoke. Of course immediately there was added to the already pungent smell in the air, a distinctly sulphurous strata, which brought the boss posthaste to find out the cause of it all, and when Jack had finished telling of his misfortune and also consigned all such things as gas jets and behind-the-times employers to regions where we have reason to believe there is no need of gas, the boss said, "Well, Jack, that is too bad; those old gas jets are sort of a nuisance and don't give very good light anyway—I think that I'll have to get the electricity put in." Jack told him that he had just about the same sort of idea about it himself, and furthermore, that it had better be done P. D. Q. or there wouldn't be many of the boys working there.

Well, time went on into days, weeks, and months, and still we had no electricity, when one day another of the boys, Eli by name, came over to my lathe and said "Say, George, just keep a weather eye on the shipper handle of my machine. I am going over on the other side of the shop and there is going to be something doing around here in a few minutes. If things get too fierce, why stop them, but don't do it before the "old man" sees it, if you can help." I looked over to Eli's lathe and saw that he had carefully placed the gas jet so that the flame was just under the shipper handle, and in a couple of minutes the handle began to smoke and finally a bit of flame started creeping up it; just about when the flame was up to the ceiling and I was thinking it time to stop it, the "old man" came tearing down the line, jumped up on the lathe and swiped his hands down the handle and put out the fire. Of course Eli showed up on the scene about then and innocently wanted to know what the trouble was. He told the boss that he thought he had that bloody gas far enough away so that there was no danger of the handle catching fire, but it had always been a mystery to him that such things did not occur oftener. The old man did not say much except that we ought to be more careful, but I guess it started something going in his "think tank," for when, a few days later, another of the boys working at that same lathe accidentally (?) allowed the same thing to happen and the fire had even started in on the ceiling, the boss said: "Well, boys, this won't happen again—I've ordered the electricity put in this week." And sure enough, a couple of days later the men were down there wiring the shop, and the day of gas was over in that place. M. A. CHENIST.

AN ADJUSTABLE REAMER

The reamer shown in the accompanying engraving differs in construction in some respects from any that the writer has ever seen, and it is such a good tool that it seemed worth



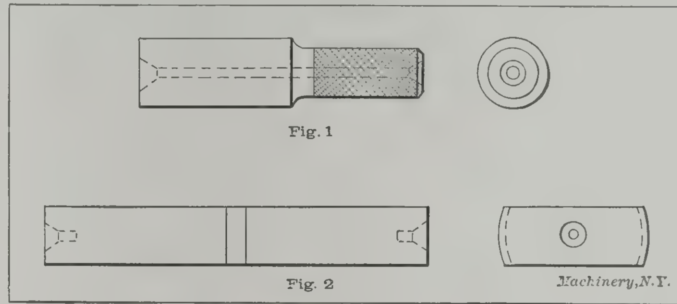
Reamer with Graduated Adjustment

while offering a description of it for publication. The means of adjustment is clearly shown in the sectioned part of the elevation. The cutters are beveled to fit the taper of the sleeve *A* at their inner ends, and are forced out by the inward movement of this sleeve, which is threaded 12 threads per inch. The taper part is turned to an angle of 16 degrees 40 minutes with the axis, and the end of the sleeve has 50 graduations, as shown in the end view, which makes each graduation equal 0.001 inch increase in diameter across the cutters. A spanner wrench is used to turn the sleeves. The cutters are brought to a snug fit in the sockets by means of tapered pins *B*, which are driven into split holes in the cutter head. The reamer chosen for this description is used for reaming 7½-inch holes. C. W. HEBERT.

Nashua, N. H.

PROVISION FOR THE ESCAPE OF AIR IN PLUG GAGES

While reading an article in the September number of MACHINERY about plug and ring gages, I noticed that the importance of lightness was especially treated; this is indeed very important. Another important feature in connection with gage construction, which applies only to plug gages, is the provision for the escape of air when such gages are to be used in blind holes or those having closed ends. Of course, in most cases where plugs are used such provision is not necesssary, as the hole to be tested passes through the work, and therefore gives the air plenty of chance to escape; but once in awhile a hole has to be tested which is closed at one end. In this case the solid plug is rendered absolutely useless, and inside micrometers or calipers have to be used, as it is almost impossible to insert the plug before the hole is about 0.001 inch or more too large. This is because the air cannot escape, and I have been wondering why makers of plugs do not put a hole through the center, as shown in Fig. 1, so that the air could pass through it. It need not be large, but should, of course, increase in size with the size of the plug.



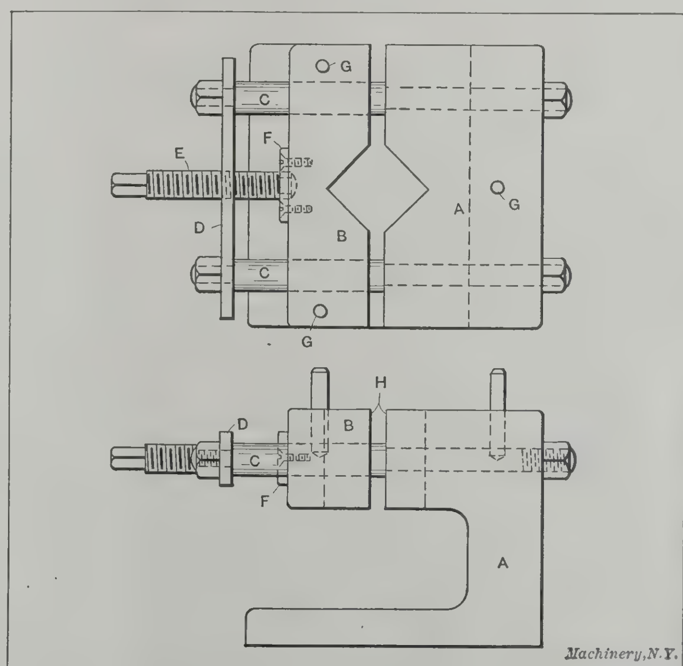
Figs. 1 and 2. Plug Gage with Hole for the Escape of Air, and Form for Large Gages

Fig. 2 shows a good way of making large plug gages. They may be made in this style for sizes from one inch and up. Gages made in this way are light, which, as stated, is an important feature, and besides, it is possible to tell with this form of gage if a hole is round or not, which may be impossible with a solid one. It is good practice to make one side of the gage with about 0.005 inch taper, especially when it is used for grinding, as it gives the user a chance to tell when he is near to the gage size. After a little practice, one will know just how much to take off by observing how far the taper part goes in the hole. A. NIELSEN.

Cleveland, Ohio.

DRILL PRESS CHUCK FOR ROUND OR FLAT STOCK

A simple chuck for the drill press is shown in the accompanying engraving. It is intended for holding round and square stock that is to be drilled, reamed or countersunk, and also for flat plates which are either round or irregular in shape. The round stock is held in the V's and the flat stock between the pins *G*. Bar stock may be clamped between the jaws at *H*. The cast-iron base *A* is machined on the bottom and top, as are the faces *H* and the V's. The part *B* is also



Drill Press Chuck that will hold Round or Square Stock or Flat Plates of Irregular Contour

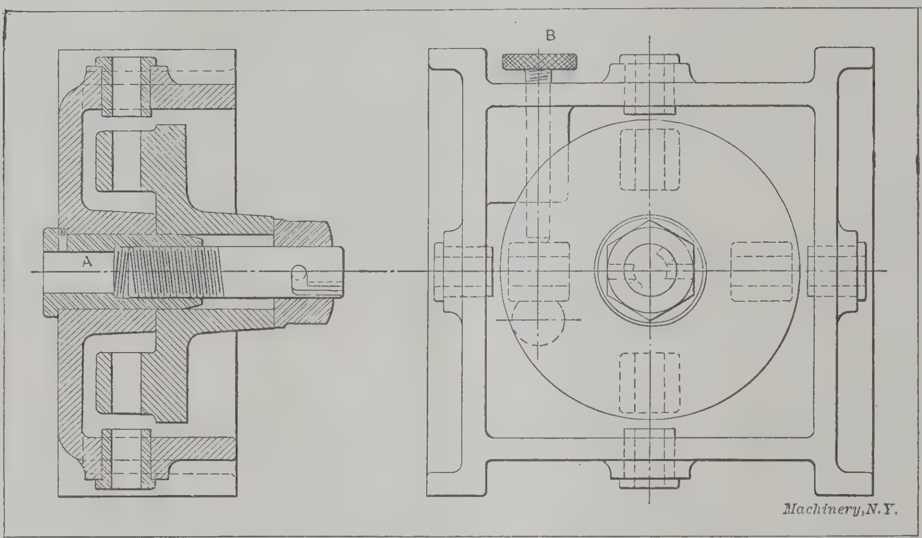
of cast iron and it is a sliding fit on the shoulder bolts *C*. Bolted across the ends of these bolts is a machine steel piece *D*, 5/8 inch by 2 1/4 inches, having a 1-inch drilled and tapped hole to receive the clamping screw *E*. This screw, which is 1 inch in diameter, has its outer end squared to receive a wrench. The inner end, which is reduced to 5/8 inch, passes through a hole in plate *F* to which it is loosely riveted. Plate *F* is secured to the jaw with 7/16-inch countersunk screws. This chuck will also serve the same purpose as a vise.

MACHINIST.

QUICK-RELEASING NUT FOR JIG WORK

The application of an efficient type of quick-releasing nut to a box drill jig is shown in the engraving. By referring to the sectional view, it will be noticed that the work is centered by the nut *A* and located also by a knurled screw *B*. As there was a fairly large quantity of these pieces to drill, it was necessary to save time in every possible way. Previously a hexagon-head screw was used for clamping, but insertion and removal of the work took much longer than it should have done. The idea then occurred to me of using a bayonet lock-nut the same as is employed for cutters on facing bars. The sketch shows a hexagon nut with two pins driven in diametrically opposite to each other. These pins fit into corresponding slots in the stud, and all that needs to be done to remove the work is to turn the nut half way around, when it can then be removed from the stud. This method of clamping thus saves the time which would be required for screwing a clamping screw in and out.

LORIENS.



Jig equipped with Quick-releasing Nut that facilitates Insertion and Removal of Work

DESIGN OF TOOL CHESTS AND CASES

As one looks over the mechanical papers of to-day he cannot help but notice the neat and compact design of tool chests that are being advertised and placed upon the market by enterprising firms. No doubt this design is the outgrowth of the call from young men who travel from one end of the country to the other partly from curiosity to see this great republic and partly from a desire to gain wide experience, but who feel that the expressage on a chest the size of a small trunk is too large a drain on the pocketbook for the extra returns in wages received. When one starts to pack one of these modern tool chests, he cannot fail to be impressed with the fact that the tool manufacturing concerns are far behind the times in the designs of tool cases for such tools as micrometers, bevel protractors, height gages, and plain squares. In many instances the cases that come with such tools occupy the lion's share of the tool chest and are many times left behind on this account. The writer would suggest that the makers of such tools place upon the market cases of a flexible type made of leather or other material that would answer this purpose and advertise the same in their catalogues or mechanical papers, and he feels sure there would be a ready demand for them.

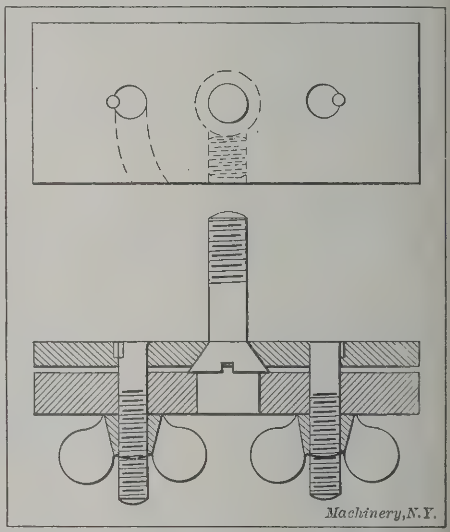
JOHN F. WINCHESTER.

Salem, Mass.

FIXTURE FOR HOLDING COUNTERSUNK SCREWS

As a number of 5/16-inch countersunk screws had to be threaded right up to the head for a certain job, and as those in stock were only threaded about two-thirds their length, I made a fixture as shown in the illustration for holding them while the die was used to cut the extra thread. As will be understood by referring to the plan view, the work was inserted or removed from the fixture by swinging the top plate to one side. To prevent the screw from turning, a plug with a tongue fitting the slot in the screw head was inserted in the hole in the bottom plate. This plug, which is held by a set-screw, was made removable so that it could be replaced in case the tongue should twist off.

ORIGINAL.



Fixture for Holding Countersunk Screws while Extra Thread is being cut

SHEAVES FOR MANILA ROPE

Very little is being written on rope driving in technical papers, although this subject should be of almost universal interest to shop owners, etc., as the transmission of power by means of ropes has become an established fact.

In a general inspection of catalogues of manufacturers of power transmission material, it would appear that very little attention is given to the details of sheave construction; however, next to the ropes, the most important detail is the construction of the sheave, as the best of ropes will be quickly put out of commission if the sheaves are not perfectly smooth as to grooves, well designed, etc.

There seem to be three different angles used for grooves, 45, 50 and 60 degrees, but the 45-degree angle appears to be the most generally adopted, and it will be found that this angle will give the best results for both the English and the American systems of rope driving. It is contended by some that 45 degrees for the English and 60 degrees for the American system is the most correct, but no sound argument has yet been made why the American groove should not be the same as the English system, or 45 degrees.

The word "split," where it is used in reference to sheaves, appears in many catalogues. A split wheel, as it is generally understood, is cast whole with cored slits; wedges are then driven in the cored slits to split the wheel, and this gives fractured joints. This method is used for belt pulleys, but should not be used on sheaves. Sheaves, if not made solid, should always be cast in two pieces, the joints planed, the bolt holes drilled, reamed and fitted with finished bolts. Fig. 1 shows a sectional view of grooves as generally found in catalogues, for the English or multiple system. As generally shown, dimension *t* remains the same, whether the sheave is for one or more ropes. Section *t* is made stronger than section *f* to avoid breaking in handling; but, for instance, take a sheave that is made for ten 2-inch ropes: Section *t* will appear to be nicely proportioned, but for a sheave with two 2-inch ropes, this section will be all out of proportion with section *f* (see Fig. 2). Of course, section *t* cannot fall below a certain

thickness, but there is also no reason for making it the same for any number of ropes.

In laying out the grooves, we will find that for sheaves having six or more ropes, a certain standard for section *t* will be all right, but for sheaves having less than six ropes, the dimensions given in the accompanying table will be more in accord with section *f* for sheaves up to 60-inch pitch diameter. Sheaves larger than 60-inch pitch diameter may have

TABLE GIVING THICKNESS FOR SECTIONS t AND f FOR SHEAVES UP TO 60-INCH PITCH DIAMETER AND FIVE ROPES OR LESS

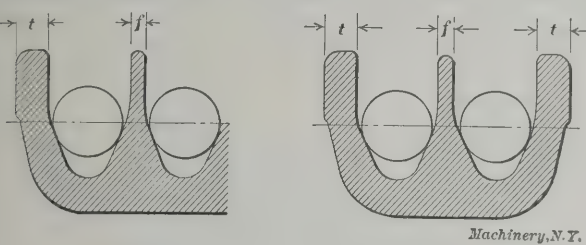


Fig. 1. Fig. 2.

Size of Rope in inches	t	f	Size of Rope in inches	t	f
$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{16}$	$1\frac{1}{2}$	$\frac{9}{16}$	$\frac{3}{8}$
$1\frac{1}{4}$	$\frac{7}{16}$	$\frac{3}{8}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{3}{8}$
$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{8}$	2	$\frac{11}{16}$	$\frac{3}{8}$

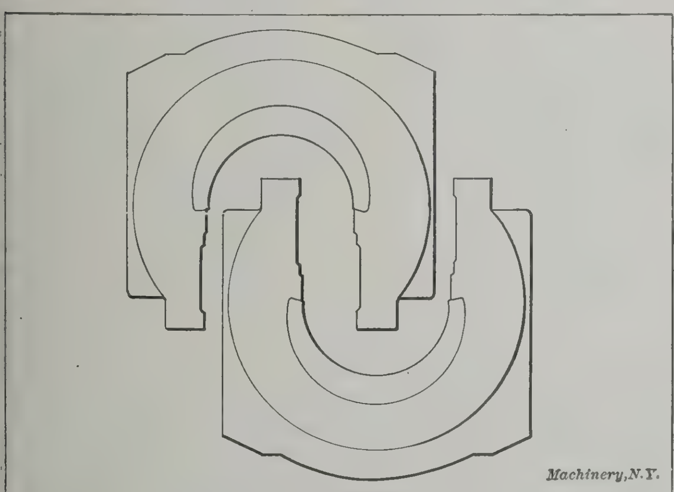
the regular thickness for section *t*, as shown in Fig. 1, as they become too heavy if the dimensions given in the table are used.

Arguments, etc., as to the advantages of rope driving, may be had from any manufacturer of Manila ropes. There is no doubt that for main drives, ropes have proved superior to belts, but for counter and machine driving, belts are still generally used. AUGUST WACKERMANN.

Pittsburg, Pa.

CENTER REST FOR DRIVING BOXES

A machinist brought a pretty good shop kink to my notice the other day for laying out a set of driving boxes—one that saves a lot of time and trouble. In most shops when laying out a driving box the machinist fits a piece of wood in it to hold the center for his dividers. Instead of so doing, if the machinist will just slide the other box leg in between the



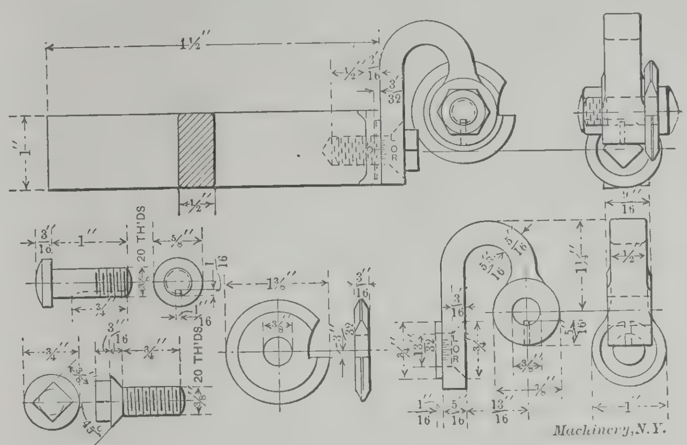
Simple Way of obtaining a Center Rest when Laying Out Driving Boxes

sides of the box being laid out, as shown in the illustration, he will have a good solid piece of iron, which is the same height as the box, on which to lay off the center. As the boxes are heavy, they stay in place and the two can be laid out at the same setting, using one to hold the center for the other. A. G. JOHNSON.

Two Harbors, Minn.

A SPRING THREADING TOOL

A tool designed for use in cutting master taps, screw gages, and other parts where accuracy is desired, is shown in the engraving. It has all the advantages of a spring tool and is equipped with a removable cutter which can be sharpened and replaced without resetting. The principal advantage lies in the fact that the shape of the cutter may be ground to any desired degree of accuracy and no dependence need be placed on thread tools or gages bought in the market. The cutters are first rough turned, hardened, the hole lapped, and the faces ground parallel. They are then placed singly on a mandrel, and ground to the proper included angle and to a perfectly sharp edge. It will be noticed that the cutting edge

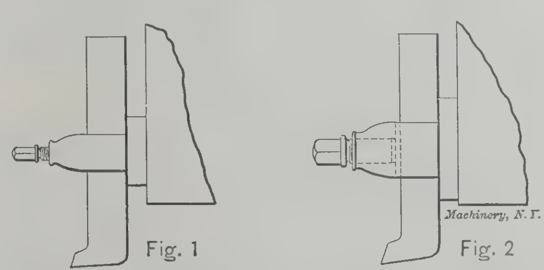


Circular Threading Tool with Spring Holder which may be adjusted for Right- or Left-hand Threads

is not radial, but to give clearance, is ground on a line 3/32 inch below, and parallel to the horizontal diameter. To secure the proper angle at this point, the center of the grinding spindle should be dropped 3/32 inch lower than the center of the cutter arbor, when grinding. If the cutter is to be made for U. S. S. or Acme threads, after grinding to a sharp edge, it is carefully measured on this diameter, the amount of flat calculated and subtracted therefrom, and the sharp edge reduced to this dimension. The engraving plainly shows the construction of the holder, by means of which the cutter can be tilted for right or left-hand threads. The lip of the cutter should be horizontal and the height of the lathe centers. T. CAIN.

HEAVIER TOOL-POSTS FOR SHAPERS

Some of the so-called high-duty shapers are equipped with rather insignificant looking tool-posts, as shown in Fig. 1, having screws entirely too small for holding the tool. The tool-post screw for 18-inch shapers and over, where a single



Figs. 1 and 2. Light Form of Tool-post found on some Shapers, and Suggested Change

screw is used, should be at least 1 inch in diameter (instead of ⅝ inch) as shown in Fig. 2. The tool-post can then be depended upon to hold the tool right where it is wanted.

Brighton, Mass. F. RATTEK.

* * *

PROTECTING POLISHED STEEL WORK FROM RUST

Polished steel work may easily be protected from rust by the application of the following compound:

Lard	6 parts
Rosin	1 part

The two ingredients are melted together and stirred until cold. The rosin prevents the mass from becoming rancid and also acts as an air-tight film. If rubbed upon a polished steel surface, even very thinly, it effectually preserves and protects the polish. It is easily removed by gasoline or kerosene. —*Brass World.*

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

DEEP HOLE CALIPERS

J. W. M.—I have to determine the size of a hole at the bottom of a 4-inch bore about 12 feet long. What is the best means of accurately calipering under such conditions, using either a standard measuring device or home-made contrivances?

A.—The best means depends on the character of the work, and the degree of accuracy required. The question is referred to our readers for suggestions. Descriptions of deep-hole calipering devices will be acceptable.

OILING MACHINE PARTS WHEN ASSEMBLING

G. B. D.—Should a taper pin be oiled before driving it home?

A.—A taper pin should be oiled before driving home, and in fact almost all ordinary machine parts should be lubricated before assembling whether they are pins, bolts, screws or other members. If a taper pin is oiled before being driven into place, it can be put into place with lighter blows, and will be less likely to work loose than if put in dry.

SETTING A THREAD TOOL FOR THREADING TAPER TAPS

A. B. C.—Should a thread tool be set square with the tailstock spindle or square with the surface of the taper when cutting the thread of a taper tap, assuming the work is done in a lathe provided with a taper turning attachment?

A.—The tool should be set square with the tailstock when threading a taper tap in a lathe provided with a taper attachment. The rule is to set the tool square with the center line of the tap. If the threading is done with the tailstock set over, the tool may be set square with the surface of a straight arbor of the same length of the tap, held between the centers.

TO CALCULATE THE WEIGHT OF HEXAGON BAR STOCK

G. V.—Please give a rule for calculating the weight of hexagon bar stock.

A.—Square the thickness of the stock across the flats and multiply by 0.866, and the area thus obtained by the length, to obtain the volume. The volume, in cubic inches, multiplied by the weight of a cubic inch of the material is the weight. Example: Suppose that the weight of a steel hexagon bar 2 inches across flats and 12 inches long is required; $0.866 \times 2^2 \times 12 = 41.568$, which multiplied by 0.283 pound, the weight of one cubic inch of steel equals 11.76, the weight of the bar, in pounds.

WARPING OF PUNCHED COLD-ROLLED PLATE

F. G. S.—We make a number of 1/16 inch thick cold-rolled 10- by 14-inch sheet steel plates with about sixty 1-inch holes, punched or drilled. We have tried both drilling and punching but the plates have sprung and buckled to such an extent as to make their use impossible. We have tried rolling, peening, heating and laying between heavy cold plates, but all to no avail. Can you suggest a remedy for our trouble?

A.—The difficulty is one that you probably cannot overcome with the material used unless it is annealed before drilling or punching. Cold-rolled stock is in a state of stress due to the cold finishing process. The surface is in a state of compression and the interior in a state of tension. A cold-rolled bar or plate remains straight so long as the interior and exterior forces are balanced as they were when leaving the rolls, but if metal is removed from the surface a change of shape immediately results. This will be observed in turning cold-rolled shafting or cutting long keyways in same. When you punch or drill holes in the plate, the interior and exterior stresses readjust themselves with the resulting change in shape noted. You must carefully anneal the plate before punching or drilling, or use some other material.

PROBLEM IN METAL SPINNING

R. L. C.—I have to do the job of metal spinning, shown in Fig. 1, and am doubtful as to the best method to follow in spinning this shape. The shell is to be 20 inches diameter, 6 inches deep, and 0.060 inch thick. The metal to be used is zinc.

A.—This is an interesting metal spinning job, and not a particularly difficult one. The shell can be best spun with the aid of two spinning forms, such as are illustrated in Figs. 2 and 3. These forms should be made of kiln-dried maple if there are comparatively few shells to be spun. If there are many, the form should be made of cast iron. Fig. 2 shows the first form to be used, which conforms to the outside of the shell as far as the centers of the spherical ring. Beyond these points, the form is straight. The blank to be spun is placed as indicated by the dotted lines, and follower No. 1 is used to hold the work against the form. The chief trouble

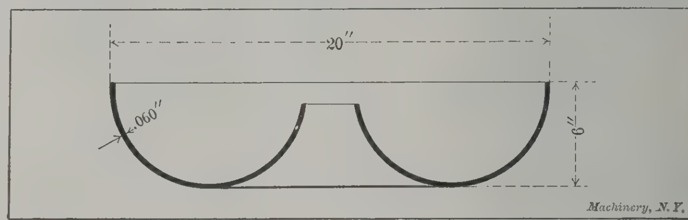


Fig. 1.

will be met in properly starting the shell, because of the small follower that must be employed. However, follower No. 2 may be substituted after working the metal back against the form a few inches, and as this gives a better grip on the shell, there will be no further danger of slipping. After spinning the zinc shell to the shape of the first form (Fig. 2) it will probably have to be annealed, but this can only be determined by trial. In annealing zinc, the flame should not be allowed to touch the metal. The half completed shell is then put on form No. 2 shown in Fig. 3. It is an easy matter to spin the metal around to complete the arc. The dotted line shows the position of the shell before starting the last part of the spinning. Of course, it will be understood that the shell must be trimmed several times during the spinning, and if the trimming is frequently done, a well-shaped shell should

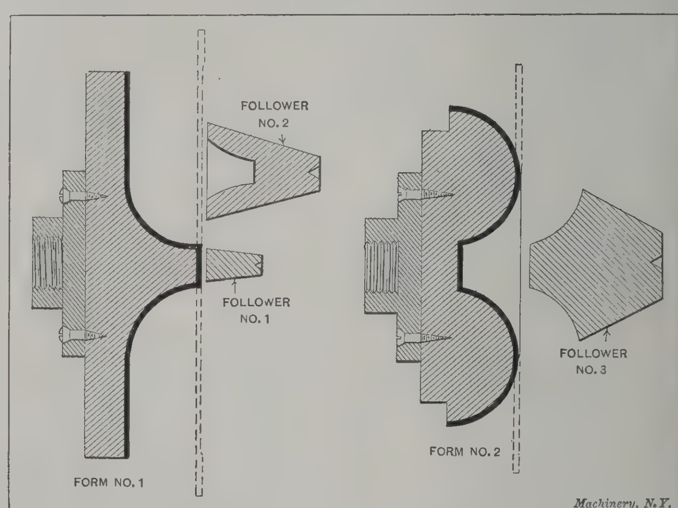


Fig. 2 Fig. 3

result. For spinning on form No. 2, follower No. 3 must be used. Either beeswax or soap should be frequently rubbed over the work while spinning. If it is necessary to cut out the center, it can be done before removing the shell from the last form by simply removing the follower and using a diamond point tool, or in large product work the swivel cutter will work well. The shell will cling to the form without the follower. The spinning speed should be from 800 to 1,000 R. P. M.

* * *

Considerable attention is given by the German technical institutions to the science of aeronautics. A bill has been introduced in the Diet of Würtemburg, asking for $2,250 yearly for a chair in aeronautics at the Stuttgart Technical University. The government also announced that a sum of $12,000 has been offered privately for the purpose of establishing a laboratory for aeronautics in connection with this chair.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

BECKER FRICTION FEED VERTICAL MILLING MACHINE

An interesting type of vertical milling machine, embodying some radically new features, has recently been brought out by the Becker Milling Machine Co., Hyde Park, Boston, Mass. This machine will be built in four sizes, known as Models

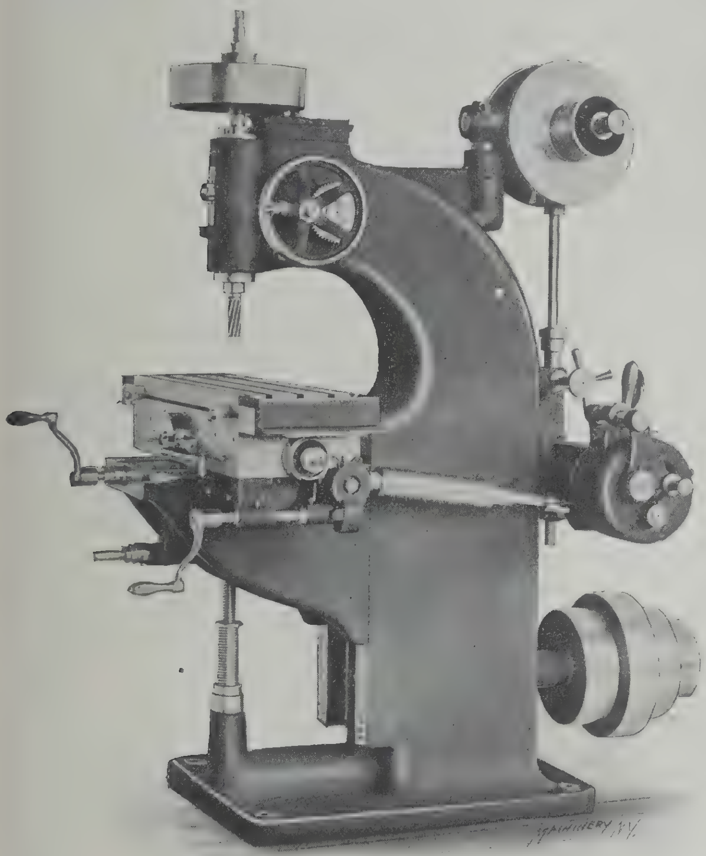


Fig. 1. Side View of Friction Feed Vertical Milling Machine, built by Becker Milling Machine Co., Hyde Park, Mass.

A, B, C and D, respectively. The accompanying half-tone illustrations show the model A machine, and the description applies in particular to this size; but all the sizes to be built embody the same features, with slight modifications in such mechanisms as the back-gearing, gear boxes, etc., which, of course, on the different sizes are made to suit the requirements for, and capacity of, each machine. Fig. 1 shows a side view of the machine and Fig. 2 a rear view, exhibiting some of the important features of the feed mechanism.

Main Spindle Drive

The main drive of the machine may be either by means of a three-step cone pulley as shown in Fig. 1, or by a constant speed single pulley drive, the power being obtained directly from an electric motor or from a pulley on the line shaft. When the single pulley drive is employed, a gear box of simple design and similar in principle to the feed gear box, which will be described later, is made use of in order to obtain the required speed variations on the driving pulley of the machine, which is belted directly to the pulley on the vertical spindle. This gear box provides for five speed changes. The machine shown is not provided with back-gearing, but if required, back-gearing arranged practically on the same principle as that of a lathe, and enclosed in a very compact gear box placed immediately beneath the pulley on the vertical spindle, is provided. The back-gearing for the model A machine is of the regular type, and for the larger sizes, of the double type, so that by means of the back-gearing and a gear box on the main driving shaft, 10 speeds on the model A machine and 15 speeds on the larger sizes may be obtained. Five of these speeds are obtained without the back-gearing, using open belt drive.

As is clear from the illustrations, Figs. 1 and 2, the 3-inch belt from the driving pulley at the bottom of the column passes over two idler pulleys. These pulleys, as is seen in Figs. 2 and 3, are mounted on the hubs of large friction disks that operate the feed mechanism which will be described later. The spindle speeds obtainable by the gear box when the constant speed pulleys run at 405 revolutions per minute—the speed recommended by the makers—are 80, 120, 180, 270 and 405 revolutions per minute. If it be desired to obtain higher speeds than these, a two-step cone pulley may be provided on the machine, and two pulleys of the required size placed on the line shafting. By this simple means another five speeds may be obtained of 150, 225, 335, 505 and 760 revolutions per minute, without resorting to back-gearing.

The column is cast in one piece, so as to insure rigidity. The vertical movement of the spindle head is obtained by means of a hand-wheel on the side of the machine, as shown. The spindle is hardened at the main bearing, and finished by grinding. The bearing boxes are made of bronze, and provided with simple means of adjustment. The head is cylindrical, which insures perfect alignment, and is provided with a micrometer stop gage, placed, as indicated in Fig. 5, in the slot at the front of the column of the machine. The graduated collar of this stop gage is of large diameter, so that each gradua-

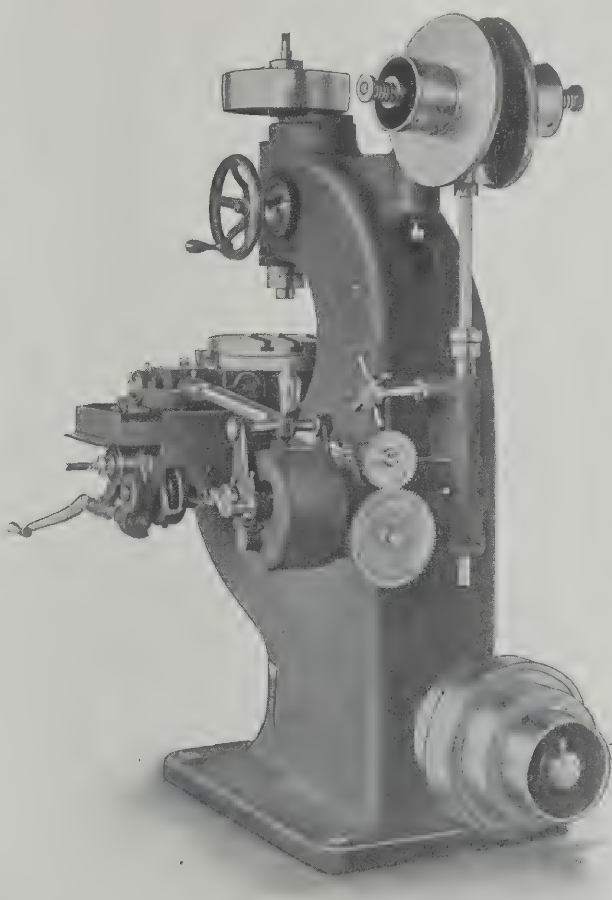


Fig. 2. Rear View of Becker Milling Machine, showing Friction Feed

tion corresponding to 0.001 inch is nearly 1/16 inch wide. This makes it possible to obtain very accurate adjustments without difficulty. At the lower end of the slot in the column a small projection or shelf is provided, on which can be placed circular gage blocks about 1½ inch in diameter, carefully made to standard thickness. By means of these gage blocks it is possible to bring the head down any definite amount; for instance, if it be required to bring the head down exactly three-quarters of an inch after one cut has been made

over the work in the machine, the micrometer stop is first brought against a ¾-inch gage block placed on the shelf or on the top of other gage blocks, and when the first milling cut has been completed on one lever, the ¾-inch gage block is removed and the head brought down until the stop rests against either the shelf or the remaining gage blocks, and the work is completed. By different combinations of gage blocks it is possible to obtain close measurements for all movements of the head. If it is required to move the head

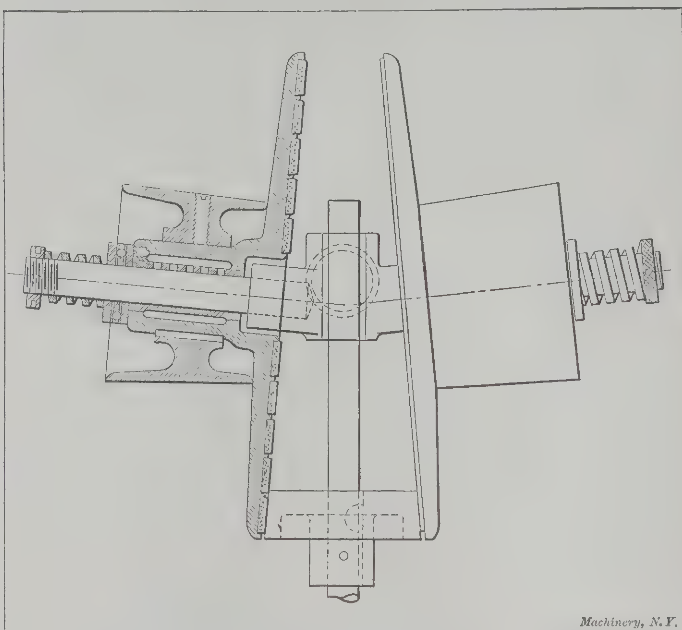


Fig. 3. Friction Feed Disks and Mounting of Idler Pulleys

only a few thousandths of an inch, the stop, of course, is brought against the gage blocks and then the graduated collar is turned the amount required, to raise or lower the head.

Friction Feed of the Machine

The distinctly novel and, without doubt, the most interesting feature of the machine is the friction feed drive. This drive may be defined as being a positive friction feed, inasmuch as the belts on the driving pulleys of the machine will slip or be thrown off their pulleys before the friction feed will cease to operate even on the heaviest cuts. This is due to the ingenious arrangement of the friction disks and the manner in which the pressure is applied to them. It will be noticed in Figs. 2 and 3 that springs are provided on the ends of the studs on which the friction disks are mounted, these springs tending to add to the pressure on the friction roller, but it has been found that by the arrangement employed these springs are unnecessary and can be removed. The pressure is furnished entirely by the driving belt passing over the idler pulleys, which are mounted on shafts placed at an angle upward and backward with the horizontal, as indicated by the position of the friction disks at the ends of the pulleys in Fig. 2. This angular arrangement produces an inward pressure of the belt on the idler pulley, which, in turn, is transmitted to the friction disks and used for obtaining the required pressure on the friction roller.

As there are two idler pulleys both placed at corresponding angles and the belt passes over both with practically the same tension, the drive is balanced, and the difficulty with friction drives usually encountered—that of providing adequate thrust bearings—is eliminated. The angle of the friction roller is 10 degrees on each side, it having been found that with the arrangement used this angle will produce the greatest pressure and the most efficient transmission of power to the feed mechanism. The idler pulleys are conical, being about one-half inch larger in diameter at the outside end than at the end abutting against the friction disks. This feature throws the belt further out on the idler pulley when running at high speed, due to the centrifugal force, and this in turn tightens the belt and increases the belt tension, at the same time increasing the pressure on the friction disks and roller. Thus, the higher the speed or the heavier the cut, the greater the belt tension, and the more powerful the friction drive mechanism.

A line drawing, illustrating in a general way the arrangement of the idler pulleys and friction disks, is shown in Fig. 3. The idler pulleys, as shown by the sectional view, are not cast in one piece with the friction disks, but are fastened to the disks by keys and set-screws, the friction disk being provided with a long hub for this purpose; the hub is provided with ample means for lubrication.

An interesting feature, and one of extreme importance in a friction drive, is the method used for fastening the leather to the cast iron friction disks; one of the chief difficulties of friction drives in the past has been the trouble met with in the loosening of the leather from the disks. A common method employed has been to first attach one disk of leather to the cast iron disk by means of small pins or rivets, turning off the rivet heads level with the surface of the leather, and then attach another thickness of leather, by means of leather cement, to the one fastened to the cast iron disk. This means of fastening gave no trouble as long as the leather was kept free from oil, but as the leather in any friction drive, in order to transmit power efficiently, must be kept soft and pliable, and, therefore, must be oiled occasionally, the oil would dissolve the cement, and the leather disk would become loose.

In the construction used in the friction feed disks on the Becker milling machine, no cement is used between the leather and the disk, and therefore the required amount of lubrication can be supplied to the leather without any danger of interfering with the durability of the drive. The cast iron disk is provided with a number of concentric grooves of a dove-tail shape, as shown in section in Fig. 3. The leather, cut into segments, is pressed into these grooves, where it is held very firmly on account of the shape of the groove. When

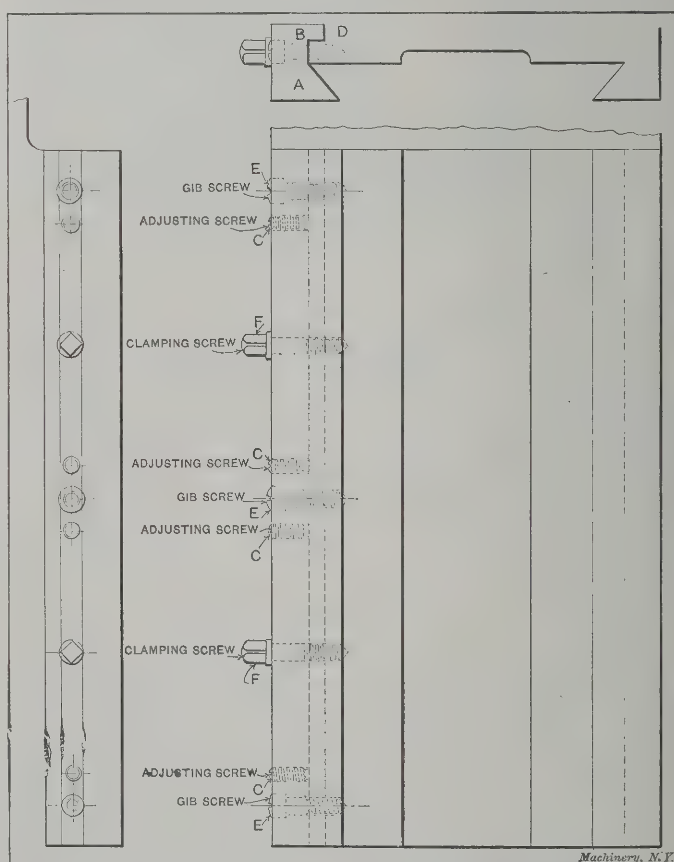


Fig. 4. Construction of Gib for Milling Machine Knee Slide

the pressure is applied to the disks against the friction roller, it is evident that the leather is still more firmly pressed into the dove-tail, so that the heavier the feed is, the firmer is the grip between the leather and the cast iron disks. The friction roller is adjusted up or down as required for different feeds by means of the small hand-wheel or spider shown in Fig. 2 at the back of the column. On the end of the shaft of this spider is a small pinion engaging with rack teeth on the sleeve of the vertical feed shaft. The power from

the vertical feed shaft is transmitted to the feed gear box shown in Figs. 1 and 2 by means of worm and worm-gear. The feed gear box is of a very simple construction. It is operated by means of the handle on the top, and by the push pin on the side of the gear box shown projecting outside of its bearing. By means of this gear box five variations in feed can be obtained without varying or changing the location of the friction roller. One of these feeds is obtained without any of the gears in the gear box proper running, but

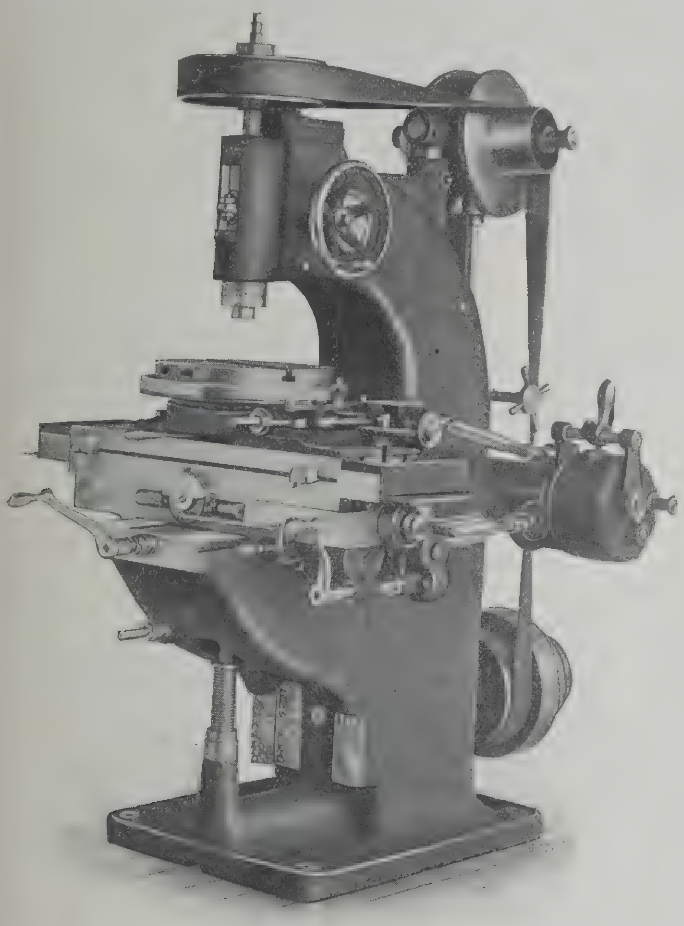


Fig. 5. Becker Milling Machine with Improved Rotary Milling Attachment

by connecting the horizontal feed shaft directly with the telescoping shaft leading to the table. In this way the loss of power incident to transmitting the motion through a great many gears is avoided, and the feed is brought to the table in as direct a manner as possible. By the combination of the friction feed disks and the gear box it is possible to obtain all feeds on the machine between 0.003 inch to 0.067 inch per revolution of the cutter. This refers to the model A machine. On the model B machine feeds can be obtained from the same minimum of 0.003 inch up to 1¼ inch per revolution of the cutter.

The design of the gear box is novel, and it differs in construction from the ordinary type in important details. Instead of using a sliding gear or tumbler moving back and forth on the tumbler shaft, the whole tumbler shaft moves by means of the push pin shown. It is placed in bearings on the outside of the gear box, thus making lubrication very easy. As there are no interior bearings to oil, there is no need of a complicated lubricating arrangement with oil tubes leading to the various bearings on the inside of the gear box.

The power of the friction drive is well exhibited by the fact that the machine will take a cut in cast iron 1/16 inch deep with a feed of 1/16 inch per revolution of the spindle, with a six-inch cutter. The larger sizes, of course, will permit of proportionally heavier cuts.

Another new feature of the machine is the arrangement of the knee slide. Instead of having a knee provided with a dove-tail slide, and the dove-tail on the column of the machine, the order has been reversed, and the column of the machine is provided with a dove-tail slide, the dove-tail being on the knee. This in combination with the arrangement shown in Fig. 4 for adjusting the dove-tail slide and binding the knee when required, makes it possible to obtain a construction without any loose gibs. The piece *A*, Fig. 4, is made a very close fit in the groove in the column at *B*. In order to adjust the slide properly for the dove-tail on the knee, the adjusting screws *C* are used, which bear against the face *D* of the column, as shown. When the proper adjustment has been obtained it is permanently retained by tightening the gib screws or binding screws *E*. When it is desired to lock the knee to the column of the machine, the clamping screws *F* are tightened, which then spring the gib between the adjusting screws *C* a very small amount, enough to hold the knee rigidly in position. This method of binding insures perfect freedom from change in alignment, and is considered by the builders as a very important improvement in milling machine design. The knee is made with a double wall box construction and is thus unusually heavy and rigid.

Mechanism for Stopping and Reversing the Table

In the front of the machine in Figs. 1 and 5 is shown a new and interesting mechanism for stopping and reversing the table at the end of its travel. Stop dogs are provided as usual, operating a mechanism shown in the center of the saddle. By manipulating the two plungers on each side of the central reversing disk, it is possible to either have the machine move constantly back and forth automatically, or to have it stop at the end of its travel to the right or at the end of its travel to the left. The manipulation of the plungers can be made during any part of either the forward or the backward stroke; the machine will stop first when it comes to the end of its stroke at either the right or left, according to which one of the plungers is manipulated. The central reversing disk is provided with a spring arrangement which throws it over rapidly to either side as soon as the stop dogs have moved it over a certain amount; a pitman connects the disk with a handle which operates the clutch between the two bevel gears used for reversing the table. This makes a very simple arrangement which is exceedingly handy and useful.

The table of the machine is provided with a cover which protects the top of the saddle from chips and dirt whenever the table is moved to extreme positions either to the right or left. This cover does not telescope, but consists of a leather shield with a sheet iron hook at its end, which holds it to the end of the saddle when the end of the table passes by this point. The other end of the leather cover is rolled up in

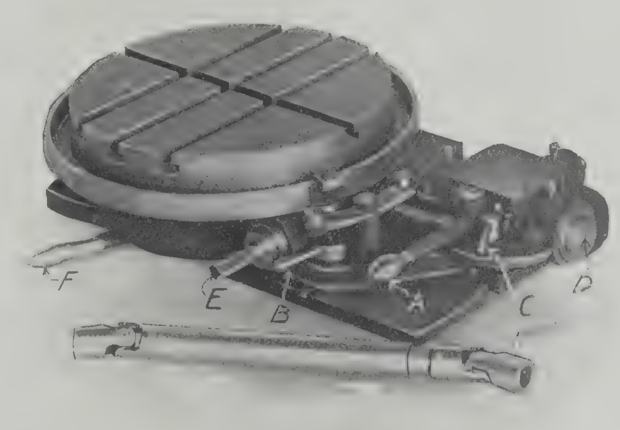


Fig. 6. Rotary Milling Attachment Removed from Table, in order to show Details

a manner similar to that of an ordinary shade. The same arrangement is used back of the table between it and the column, in order to protect the knee and the working parts contained in it from the chips when the table is moved outward.

Drive for the Rotary Milling Attachment

Another improvement which has been introduced on this milling machine relates to the drive for the rotary milling attachment shown in place on the machine in Fig. 5, and in detail in Fig. 6. In the previous types of the Becker milling machine, the rotary attachment was driven through a gear

box placed on the right-hand end of the milling machine saddle, the power being obtained through the regular telescoping shaft. In this machine, as shown very clearly in Fig. 5, the power for the rotary attachment is obtained through an independent telescoping shaft connected directly with the regular feed gear box. In Fig. 6 the attachment is shown by itself, removed from the machine; *A* is the handle which operates the clutch between the two bevel gears, by means of which the motion of the rotating table is reversed. The shaft *D* on which these two bevel gears are mounted is connected by bevel gearing with the worm-gear shaft *E*, from which the power is transmitted to the rotating table through worm and worm-gear. The motion is automatically thrown out by means of the dog shown on the rim of the rotating table, which operates the lever mechanism indicated and returns the handle *A* to a central position. The worm can be thrown out of engagement with the worm-gear by operating handle *B*, and when either thrown in or out of engagement the attachment is locked in position by the binder *C*. This arrangement has the advantage of being easily removed from the table of the machine, it being necessary only to loosen two bolts and slide it off. When required, the rotating table can be locked in position by handle *F*, and regular straight milling can be performed without removing the attachment.

General Remarks

In general, throughout the design of this machine, gears have been eliminated wherever possible. Mr. Becker, who is responsible for the design, considers that entirely too much power is lost by driving through the usual type of gear boxes, and also in obtaining feed changes through gear boxes. For this reason the drive of this machine is so arranged that even when a gear box is introduced, one set of speeds can be obtained without using the gears in the gear box; and by means of the friction feed, a wide range of feeds can also be obtained directly, without introducing the gears in the feed box. Even when the gears in the feed box are running, a maximum of two sets of gears are in engagement at a time, so that the losses due to the gearing are a minimum. The direct friction feed, when arranged as in these machines, is more positive even than a gear feed, because there is no back lash or unsteady, intermittent motion, as is likely to be the case when the gears get badly worn. As the idea of geared driving heads and speed of gear boxes has been carried rather to its extreme in some recent designs, it is all the more interesting to note the efficiency which can be obtained by returning to the older idea of using belt drives in as large a measure as possible. By means of a wide driving belt, large pulleys and high belt velocity, all the power of the regular gear-driven machine can be obtained in an open belt drive, and the present machine will do milling jobs for which the back-gears would ordinarily be used, without throwing in the back-gearing. This machine, therefore, is an interesting development in machine tool design, and will undoubtedly be received with considerable interest by the mechanical trade.

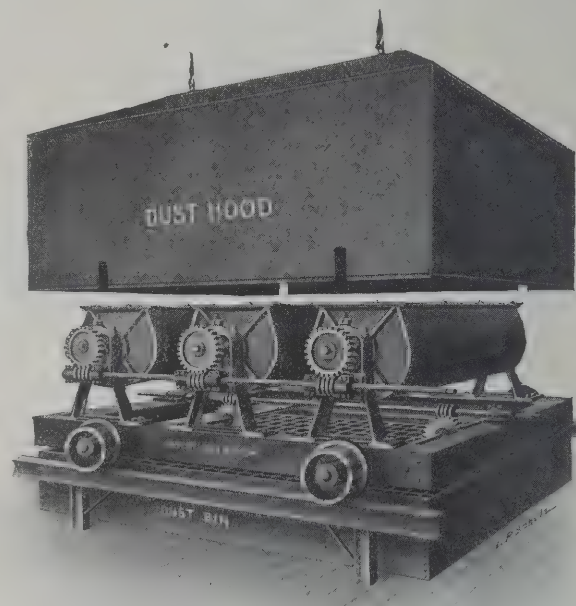
MACHINE FOR SHERARDIZING OR DRY GALVANIZING

The process of galvanizing metal products by the dry or sherardizing method has been previously described in MACHINERY (see article on the subject in the August, 1908, number). It consists, in brief, in packing the articles of iron or steel to be galvanized in air-tight drums with the impalpable powder swept from the flues of zinc smelters. This powder (known to commerce as zinc dust) consists of particles of metallic zinc, about 0.00002 inch in diameter, coated with a layer of zinc oxide. When the work thus packed is heated for the proper length of time to a temperature of 800 or 900 degrees, it is given a lustrous gray coating of zinc. Apparently the zinc dust remains as it was before, the action being somewhat of a mystery. In reality, however, the dust has parted with metallic zinc and it gradually deteriorates, though it may be used over and over again for months.

The apparatus for sherardizing shown herewith is the invention of Albert F. Schroeder, and is built by the Globe Machine & Stamping Co., of Cleveland, O. This firm established the first commercial sherardizing plant in the country, designing practically all its equipment for the purpose. Its experience in this work has been applied to the machine here shown, with the result of great improvement in efficiency and economy over the methods originally followed.

The most important improvement is in the provision made for rotating the drums in which the work is subject to action of the dust. Three of these drums, as shown, are mounted on a car, which can be pushed bodily into the heater. The constant agitation of the work and the dust together brings them into contact at every point of their surfaces, packing the zinc down into the interstices of chains or into the finest threads of bolts and screws. Where this rotating or tumbling is not resorted to, there are parts of the work which are liable to escape galvanizing on account of being in contact with each other, to the exclusion of the zinc.

The rotating of the drums also expedites the process by bringing new dust into contact with the work. It also assists in bringing the interior up to the same degree of heat as the



Schroeder Machine for Dry Galvanizing

oven, by continually bringing new hot dust from the walls to the cooler interior. This shortens the time required, as zinc dust is naturally a poor conductor of heat. For the same reason, the interior temperature tends to keep the same throughout the whole area, enabling the operator to control the process better than under the old conditions.

As may be seen the drums are rotated by worm gearing. The contents are shoveled into them through the opening made by removing a flat plate on top. To empty the drums, they are revolved half way round. The emptying takes place over a bin provided with a screen top, which allows the dust to fall through, leaving the work clear on top. The dust-hood shown is dropped over the machine during this emptying process, preventing its escape into the room. The dust-hood and bin are, of course, located outside the oven, from which the car is removed previous to tumbling.

The sherardizing process has been adopted by some of the largest electrical and other concerns of the country, and has been in successful use for several years in foreign countries.

WELLS POLISHING AND FINISHING LATHE

The polishing and finishing lathe shown in the accompanying half-tone illustration is built by the F. E. Wells & Son Co., Greenfield, Mass., and is designed for all kinds of light work, such as polishing, burring, etc., on pieces which can be held in a spring or collet chuck. As indicated in the illustration, the chuck is opened by a foot lever, which at the same time shifts the belt to the loose pulley and applies a friction brake for stopping the machine immediately. When the pressure on the foot lever is released, a spring shifts the

belt back again to its driving position on the tight pulley, and the chuck, at the same time, is closed. This arrangement makes it possible for the operator to have both hands free for handling the work.

The general dimensions of this machine are as follows: The length of the bed is 42 inches; the swing over the bed,

Polishing and Finishing Lathe, built by the F. E. Wells & Son Co., Greenfield, Mass

11 inches; and the capacity of the chuck from ⅛ to 2 inches. The width of the driving belt is 2 inches, and the weight of the machine complete is 325 pounds.

NO. 1 TILTED TURRET SCREW MACHINE

In the department of New Machinery and Tools in the July, 1909, number of MACHINERY, we described in some detail the design and construction of the "tilted turret" screw machine made by the Wood Turret Machine Co., of Brazil, Ind. The

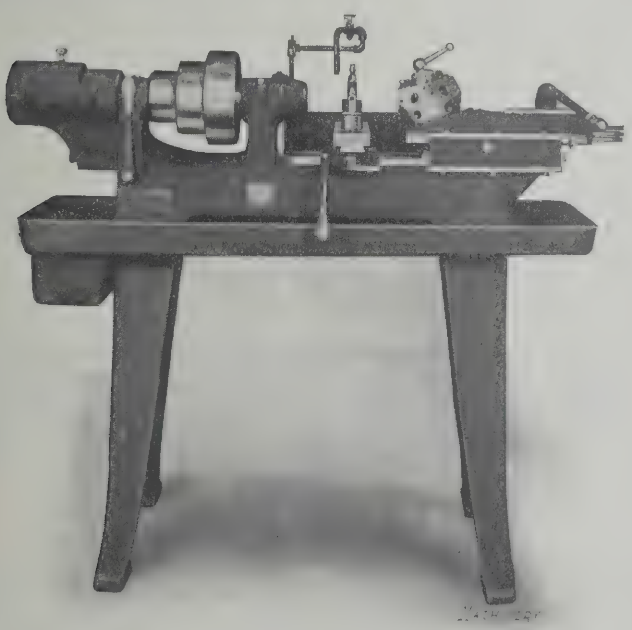


Fig. 1. No. 1 Size Tilted Turret Screw Machine

turret slide of the machine then illustrated was operated by a pilot-wheel. The accompanying illustrations show a smaller size of this machine of the same general design, but provided with a lever feed.

Fig. 2 shows this lever feed to best advantage, and illustrates as well the novel points of its construction. A rack and sector movement is used. The lever and sector form one piece, and the latter meshes with a rack secured to the turret-slide. With the usual construction on small size screw machines, the lever is pivoted to the slide, and is connected to the slide bed by a link or swiveling post. Under these conditions a changing leverage results, which requires the operator to exert more power at the start and finish of the stroke than in the middle. The arrangement shown in Fig. 2, however, permits the operator to exert the same pressure against the work at all parts of the stroke, allowing a much greater effective length of motion, so that longer cuts can be taken than on other machines of the same capacity.

The general construction of this machine is the same as with the designs previously illustrated. The tilting turret, from which the machine takes its name, will be readily recognized. It allows the stock to pass into or directly through the turret head, the center bolt being bored to permit this. When projecting through, the stock passes out through one of the auxiliary holes in the lower half of the turret in the rear, without interfering with tools clamped in the rear position. The construction has other incidental advantages as well. The strain on the center bolt is minimized, since the angular setting of the turret applies a part of the thrust directly onto the slide, doing away with the tipping occurring with the old style high turret. Furthermore, the construction permits the use of die heads or box tools of larger diameter than on other machines of the same capacity and the same swing.

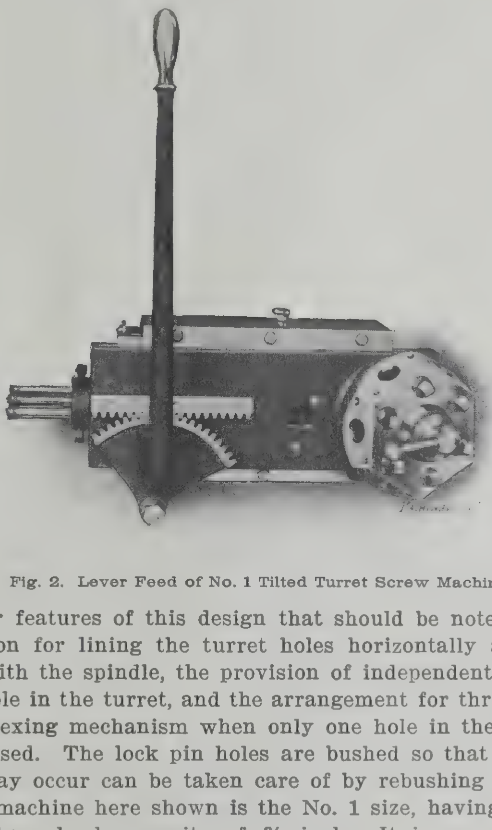


Fig. 2. Lever Feed of No. 1 Tilted Turret Screw Machine

Other features of this design that should be noted are the provision for lining the turret holes horizontally and vertically with the spindle, the provision of independent stops for each hole in the turret, and the arrangement for throwing out the indexing mechanism when only one hole in the turret is to be used. The lock pin holes are bushed so that any wear that may occur can be taken care of by rebushing the holes.

The machine here shown is the No. 1 size, having an automatic bar chuck capacity of ¾ inch. It is provided with an automatic stop feed. This tool may be seen in operation at the demonstration shops of Hill, Clarke & Co., in Boston or Chicago, or at their branch offices in New York, Philadelphia and Cleveland.

BAKER BROS. NO. 0 CYLINDER BORING MACHINE

The illustrations herewith presented show the well-known drilling machine made by Baker Bros., of Toledo, O., in a design especially adapted to automobile cylinder boring. This machine is the smallest member of a line which includes five sizes and types of single, double and four-spindle machines. This particular one is designed for boring small cylinders, being rated for diameters up to 3¾ inch and depths up to 8 inches. This is its range with maximum production, but it will easily bore much larger diameters, as it is provided with an unusually powerful spindle driving mechanism.

A distinctive feature of the machine is the provision made for employing boring bars of nearly the full diameter of the cylinder being bored. It is this feature which accounts for

the large output of which the machine is capable. The bar is driven from the spindle by a tongue and groove joint as shown. It has a bearing in a housing bracket, which is secured to the front of the machine, and carries a bronze bushing fitted to a taper seat. This provides adjustment for the bearing of the hardened boring bar, which is thus held so closely that there is no danger of its following the cored hole.

It is customary to set these machines up in gangs of three or four units. Where the cylinders are reamed, they are roughed under the first spindle, straightened under the second and reamed under the third. When two cuts only are taken before grinding, the cylinders are roughed in the first and third spindles and straightened in the second and fourth. The method of handling the work is such that the cylinders may progress from one spindle to the next without interruption for rough boring, straightened boring and reaming. The design is such as to adapt the machine to the boring of single cylinders, twin cylinders, or four cylinders "cast in block." The engravings show the machine with a fixture for holding an unusual type of open end cylinder.

In regard to the general design of the machine, it may be said that it is adapted to high speeds and feeds. All shafts are ground, and all bearings are bronze bushed. Most of the gears are of steel, hardened where necessary, and run in a bath of oil. The machine swings 12 inches from the center of the spindle to the frame. It has 8 quick change geared spindle speeds, and 12 changes of geared feeds. A single belt-drive is provided, the design of the machine being such that it may be belted directly to the line-shaft, allowing a number of them to be placed side by side to form gangs of any required number of units. The weight of the machine is 3,500 pounds and the floor space occupied is 3 feet, 6 inches square.

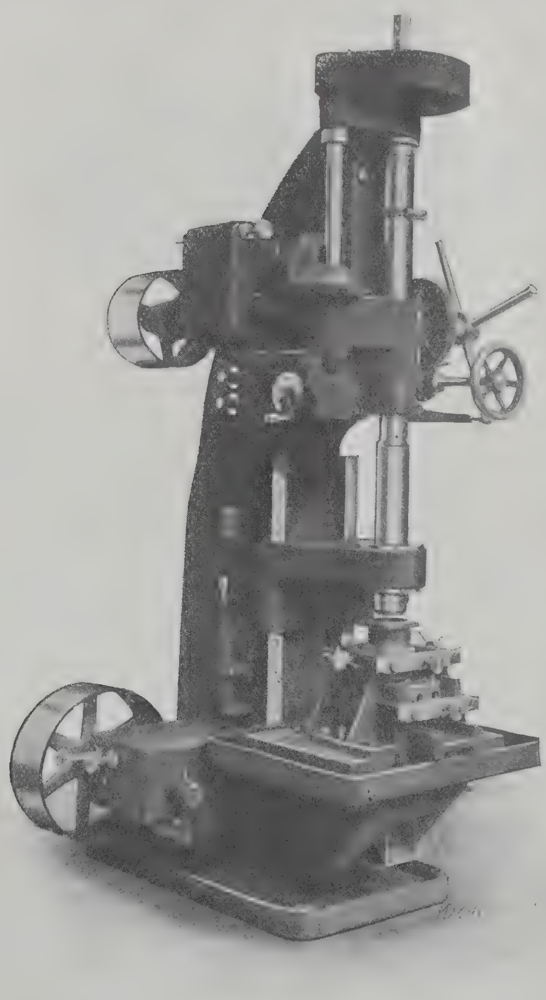


Fig. 1. Baker Automobile Cylinder Boring Machine

The makers of this tool have kept in close touch with automobile work from the beginning, and are prepared both to design and build tools and fixtures for use in machines of this type, or, if preferred, they will give their customers the benefit of their experience in this line in the way of suggestions. When required, special attachments for boring, facing and tapping the seats of automobile cylinders will be furnished. With these attachments, either two or four tools can

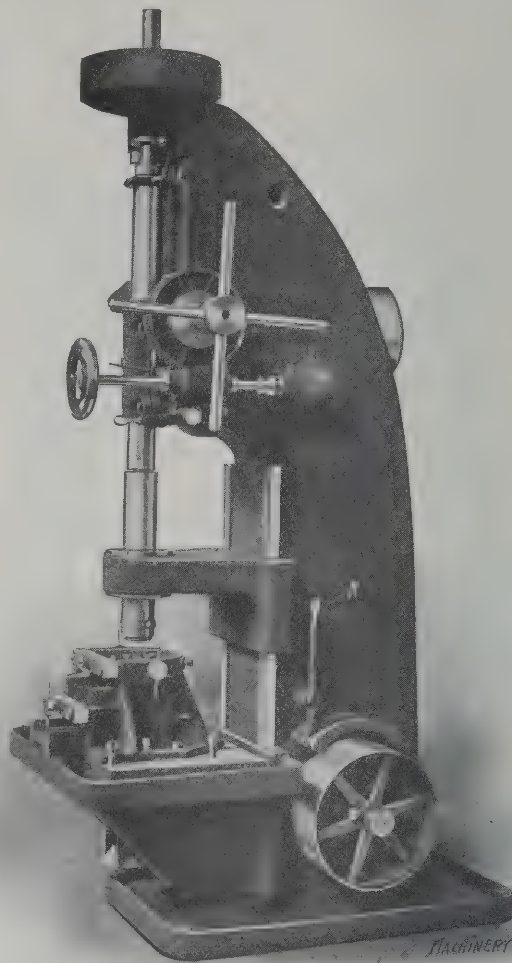
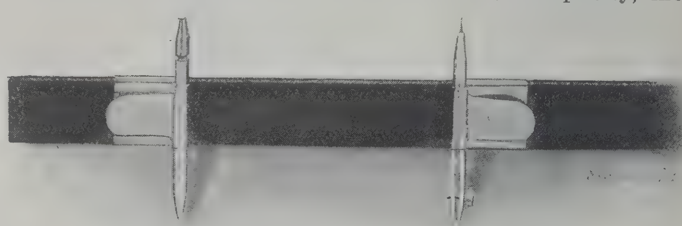


Fig. 2. Side View, showing Single Pulley Drive, Boring Bar Support, etc.

be carried by each spindle, thus materially increasing the capacity of the machine.

P. S. ANROS CO.'S BEAM COMPASS

Every draftsman has experienced the need of a light, convenient beam compass that can be quickly and accurately adjusted and still be rigid enough to insure good work. The P. S. Anros Co. of North Tonawanda, N. Y., have met this demand by putting on the market a very neat and convenient instrument of this kind. It is the acme of simplicity, inexpensive, and at the same time a tool that is thoroughly practical. The construction is such that use is made of the opposite ends of the pen and pencil for the needle points, so that either pen or pencil is instantly available by turning the instrument over. The adjustment of the sliders, which carry the pen and pencil along the beam, is particularly smooth, making it possible to set the compass as accurately as with some of the more expensive instruments. These sliders are simply spring steel bands that fit the wooden beam closely and retain their position by friction. Both pen and pencil are easily adjusted vertically, and they, like the sliders, are held in place by friction. Undoubtedly, draftsmen in need of a beam compass will find this a very handy addition to their set of instruments. The price of the tool is one dollar.

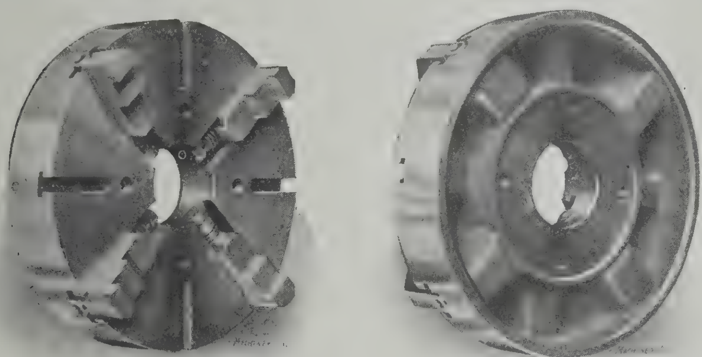


An Inexpensive but Practical Beam Compass

S. E. HORTON FOUR-JAW INDEPENDENT CHUCKS

The S. E. Horton Machine Co., of Windsor Locks, Conn., has entered the chuck field with the line of four-jaw independent chucks herewith illustrated and described. This type of chuck possesses certain advantages for general work. The jaws are reversible by simply running them out and turning them end for end; the independent control of the jaws makes it possible to handle a large variety of rough forgings, castings and pieces of irregular outline; and it permits as well, the truing up of finished work to run with any desired degree of accuracy.

In addition to these general qualifications, this design has special advantages of its own, which fit it to meet the three prime requirements of a good independent chuck—namely, the requirements of strength and gripping power, durability, and workmanship. These advantages are derived largely from the improved proportions given the jaws and screws, as shown in detail in Figs. 5 and 6.



Figs. 1 and 2. Front and Rear Views of the S. E. Horton Four-Jaw Independent Chuck, 18-inch size

The strength and stiffness of the mounting provided for the jaw are shown clearly at the right of Fig. 6. A plain T-slot is cut in the face of the chuck in place of the usual tongued groove construction shown at the left of the engraving. A glance will explain the advantage of this arrangement in the matter of the resistance of the jaw to the lateral thrust (shown by the arrow) imposed on it by the driving of the work. The broad base and liberal bearing surface give, also, unusual strength and long life to the jaws and slides.

A further advantage of this form of jaw is that it permits the use of a screw of unusually large diameter (1¼ inch for the 10-inch chuck and 1½ inch for the 15-inch size). This screw, as shown, has a complete half bearing in the jaw, bringing the tightening strain more nearly in line with the work than the usual construction allows. There is thus less tendency for the jaws to spring away from the work. In addition it should be noted that three bearings are provided for the screw, all of them on turned diameters, no reliance being placed on the threaded surface as a journal. This greatly increases the durability at a point where durability is very necessary. The thrust is so taken up on these bearings as to distribute the strain properly through the chuck body. The shell cannot break out at the end of the screw.

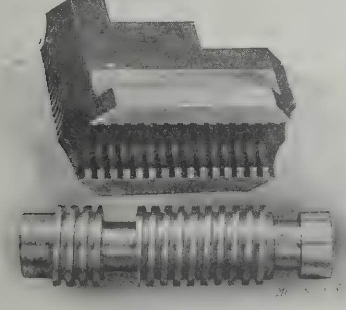


Fig. 5. The Broad Based Jaw and Large Screw

It will be seen that the socket for the wrench is formed in stock of the full root diameter of the thread, thus giving the maximum size and strength at this important point.

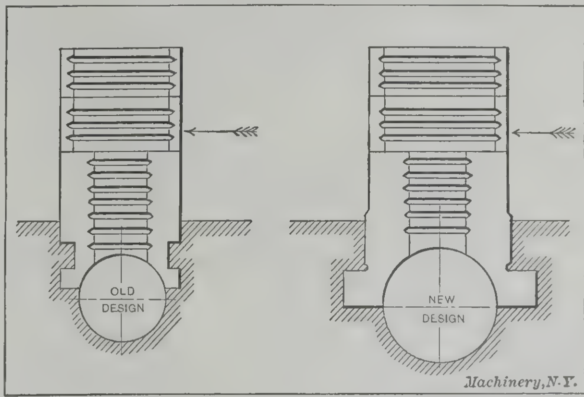
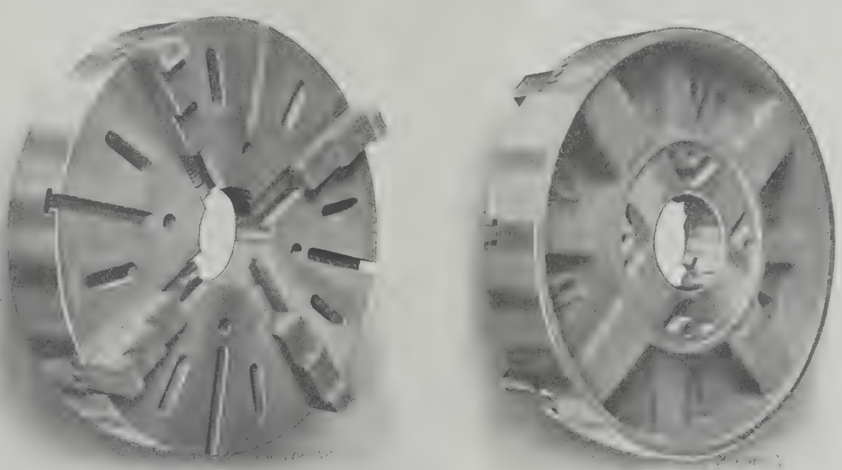


Fig. 6. Comparison of Jaws and Screws in Old and New Designs

As a result of this increase in the stiffness and durability of the jaw and screw, a much heavier clamping strain can be exerted without danger of breakage or excessive wear. For this reason, wrenches of much greater leverage than usual can be, and are, provided. The construction also permits the extension of the jaws for one-third of their length outside of the body, giving an increased capacity. This extended diameter is 11 inches for the 10-inch size, and 16½ inches for the 15-inch.

Figs. 1 and 2 illustrate front and rear views, respectively, of the 18-inch chuck. The body, it will be seen, is of standard design, but of very heavy and rigid proportions. Chucks from 20 inches up are made in the styles shown in Figs. 3 and 4, being provided with through slots for face-plate clamping, in addition to the T-slots provided in the smaller sizes. The convenience of this on large chucks is well recognized by mechanics. The hole through the body is unusually large. This feature, which is permitted by the improved design, is an advantage in holding work having a large hub; or it may be utilized, if desired, in fastening on the spindle face-plate with the hub projecting inward instead of outward as usual. This method of mounting greatly reduces the over-hang, and gives a corresponding advantage in the matter of stiffness, but the central hole of the chuck is not usually large enough to permit it. The hole through the body of the 10-inch chuck is 2¾ inches in diameter; on the 15-inch size, the diameter of the hole is 4 inches.



Figs. 3 and 4. A Larger Size of the Horton Chuck, with Provision for Using Clamp Bolts

In relation to the matter of workmanship, a study of the illustrations will show that the construction is such that accuracy is easily secured. This line also has the advantage of being designed and made by men who have been in the business for many years, and have become specialists in this work. The regular list covers sizes from 8 to 26 inches inclusive.

HAMMOND WIRE BELT LACING TOOL

A tool of simple construction for making wire hinged joints for leather belts, is shown herewith. It is intended to take the place of the more costly machine for this work. Besides having the advantage of cheapness, it has that of portability. These tools may be kept in the various tool-rooms of an establishment and checked out for bench work the same as drills, clamps, etc., it being convenient to hold them in an ordinary vise as shown in Fig. 1.

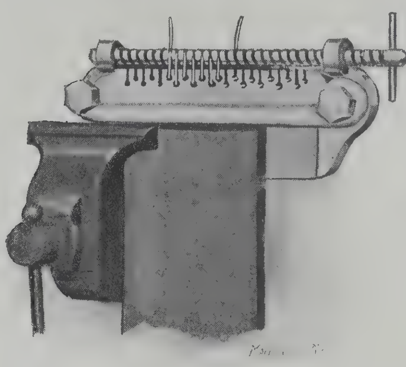


Fig. 1. An Inexpensive and Efficient Wire Belt Lacing Tool

The process of lacing the belt should be obvious from an inspection of the engravings. The threaded guide-rod is inserted in place and the belt (whose end has been squared) is pushed into place between the clamps, being fastened there with its edge resting against the guide-screw. Holes are then punched through the belt with an ordinary awl, the slots cut in the clamping bar serving as a guide. Wires are then threaded through these holes and around the guide-screw, using ordinary pliers for the operation. When the belt has thus been laced, the guide-screw is threaded out of the lacing. After the other end of the belt has been treated in the same manner, the lacings for the two ends are pressed flat in the vise, and then interlocked with each other. A rawhide pivot pressed in between the two, forms the hinge and completes the joint.

A belt thus laced is provided with a joint which has a maximum of strength, and a thickness no greater than that of the belt. At the same time, it is flexible enough to run over a very small pulley at high speed. The staggering of the holes greatly increases the efficiency of the joint. There is oftentimes great advantage in lacing a belt away from the machine, in places where such an operation in place would be dangerous or even impossible. A simple insertion of the rawhide pin completes the joint, when the belt is again put in motion.

This tool is made by Geo. W. Southwick Co., 35 Warren St., New York. It weighs only three pounds and is sold at a very low price. This tool may be used in a vise, as shown in Fig. 1, or it will be furnished with a stand, as shown in Fig. 2, for use in shops where vises are not employed.

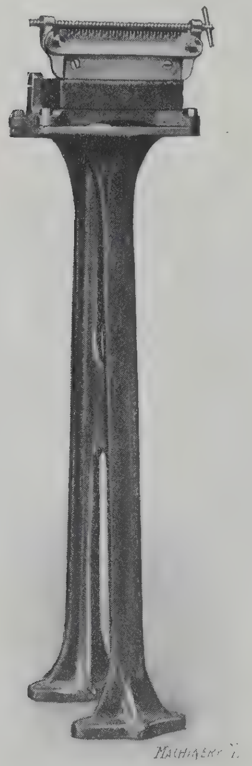


Fig. 2. Tool Mounted on Stand

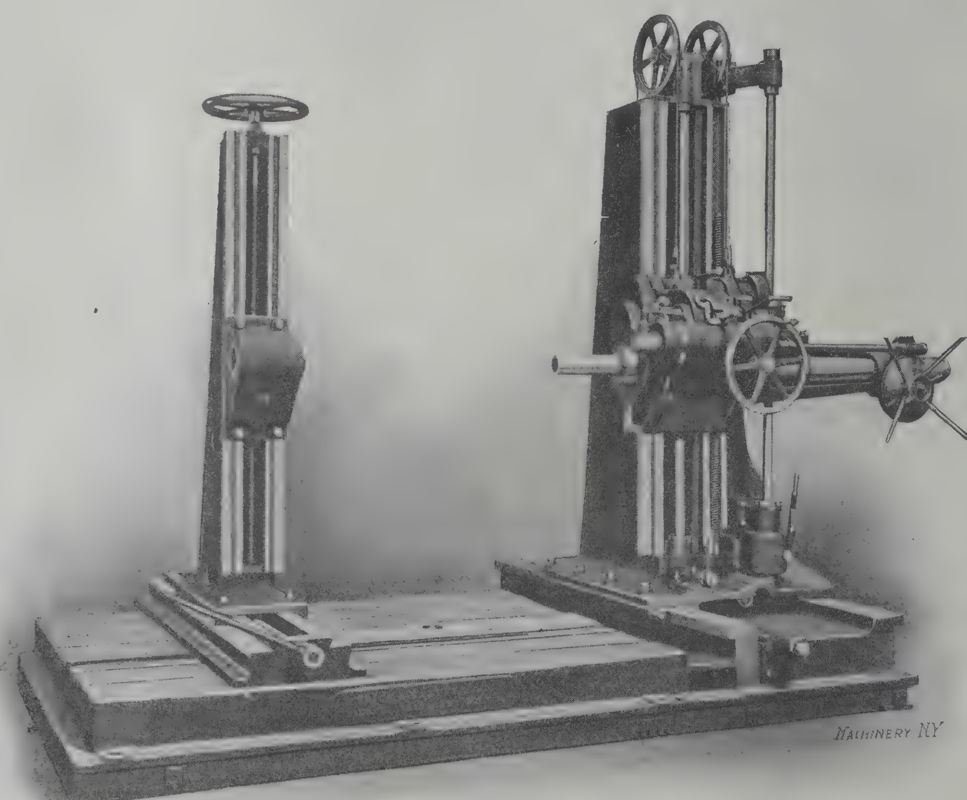
DETRICK & HARVEY NO. 1 HORIZONTAL DRILLING, BORING AND MILLING MACHINE

The accompanying illustration shows a recent design of the horizontal drilling, boring and milling machine made by the Detrick & Harvey Machine Co., of Baltimore, Md. The machine shown is the No. 1 or 50-inch size, so proportioned as to drill and bore anywhere on a surface 50 inches square.

The column is a box section tapered to a broad base, which is gibbed with a sliding fit to the bearing on the runway. This bearing is carefully scraped and guides the column between long narrow surfaces which preserve the alignment with great accuracy. The saddle or head has a vertical movement on the column by hand or by power; the same is true of the column in its movement on the runway. Six changes of power feed are provided in both these movements, of suitable range for milling operations. The bed-plate and length of runway are made in sizes to suit the requirements of the purchaser. Suitable T-slots for clamping the work-table and the outboard boring bar support, are provided.

The steel spindle carried by the saddle is back-geared at the front end, giving a direct drive for heavy face milling operations; the end of the spindle will be threaded if required, for carrying these heavy cutters. A No. 6 Morse taper hole is provided for driving end mills, drills and boring bars. The twelve rates of spindle speed range from 5½ to 125 revolutions per minute. These are controlled by levers on the saddle within convenient reach of the operator. The spindle reverse for tapping is governed by a lever at the bottom of the driving shaft on the column.

The following dimensions will give an idea of the capacity of the machine. The spindle has a maximum vertical adjustment on the column of 50 inches, and a standard traverse of the column on the runway of the same amount. The spindle is 4 inches in diameter with a feed of 30 inches. The standard work bed has 50 by 84 inches of surface. With this size



New Design of the Detrick & Harvey Horizontal Boring, Drilling and Milling Machine

of work bed, the maximum distance from the end of the spindle to the outer support is 61 inches, and the floor space occupied is 12 by 17 feet.

This machine will be furnished if desired with a universal tilting and rotating table by means of which the operator can drill and bore at any angle anywhere on five sides of a cube. This table can be firmly clamped in any position and moved in a direction parallel with the spindle, toward and away from the column. It is provided with T-slots and a central hole. A rotating table without the tilting feature can be furnished when desired.

Other extras which the manufacturers are prepared to furnish are graduated scales for the various adjustments, rotary pump for providing lubricant when drilling on steel, motor drives, etc. The machine will also be furnished without the bed-plate if desired, or for use as a portable machine. It is made in four other sizes to cover the range from 40 to 96 inches maximum capacity of vertical and horizontal movements.

STROMBERG ELECTRIC CHRONOGRAPH

An electric chronograph or time recorder for registering the exact time of the entrance or departure of employes from manufacturing or mercantile establishments, is shown in the illustrations presented herewith. Another model of the chronograph, intended for general office purposes, was illustrated and described in the New Machinery and Tools department of the February, 1909, number. Those who read that description will probably recall that this instrument is a radical departure from the usual time-recording device in that it, together with any number of instruments both for general office and in-and-out recording, can be connected in the same circuit and operated by one master clock, thereby

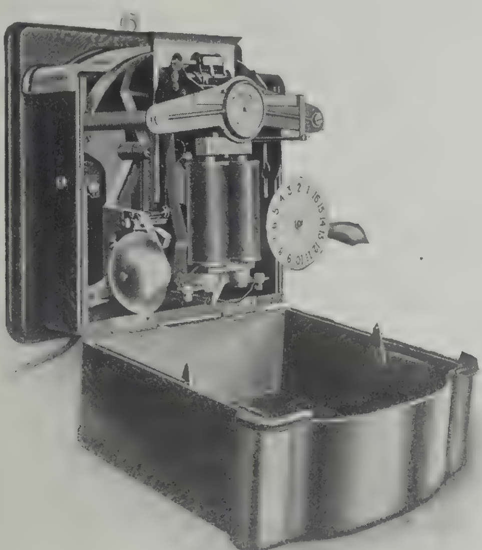


Fig. 1. Stromberg Electric In-and-out Time Recorder Opened to expose Mechanism

insuring absolute uniformity and agreement. It will thus be seen that all of the clock mechanism is removed from the recorder itself, so that the jar when registering does not in any way affect the delicate mechanism of the controlling timepiece.

Another salient feature of the chronograph is that it prints on the front of the card instead of on the reverse side, as is the case with other makes of in-and-out recorders. It is not necessary to provide a special master clock, as any factory clock equipped with a second hand can be used. The illustration, Fig. 1, shows the interior mechanism of the instrument. The printing wheels and the hand of the dial on the side of the chronograph are moved by a simple magnetic action controlled by a make-and-break device attached to the master clock. Either direct or alternating 110-volt current storage battery or primary batteries may be used to operate the instruments. For alternating current, however, a rectifier, which will be furnished by the company, is necessary to convert the alternating to direct current. The illustration, Fig. 2, shows the chronograph with the time-card cases on either side. The instrument is so made that there are no bolts, screws or other parts exposed, which can be tampered with by a malicious employe. The model for in-and-out recording is fitted with an adjustable gage which insures the recording of time in the proper place on the card, without any manipulation on the part of the operator beyond inserting

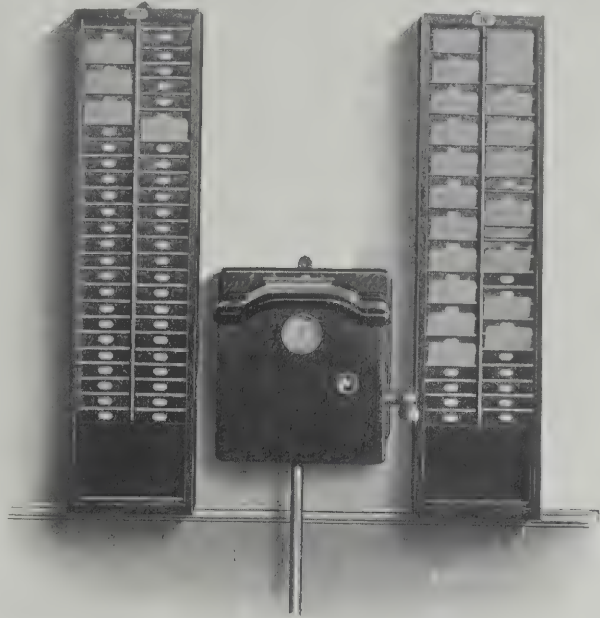


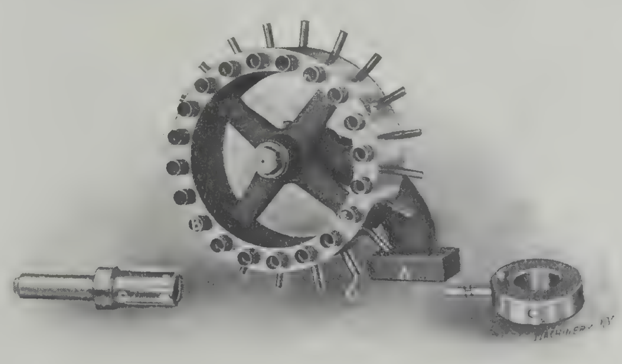
Fig. 2. The Chronograph and the Time-card Filing Cases

the card into the chute and depressing the printing arm in the usual manner. When this is done, an exact and indelible record of the time of arrival or departure is accurately recorded. The chronograph is manufactured by the Stromberg Electric Mfg. Co., 108-128 North Jefferson St., Chicago, Ill.

CLEVELAND ROTARY MAGAZINE ATTACHMENT

A special rotary magazine attachment has just been brought out by the Cleveland Automatic Machine Co., Cleveland, Ohio, that is exceedingly simple in its construction and yet, undoubtedly, a most effective piece of mechanism. This is not a regular attachment, but simply a new fixture which has been devised to handle some of the second-operation work which, because of peculiar shapes, cannot be easily handled in a standard tilting magazine. This new drum magazine can be applied to any "Cleveland" automatic, and it is recommended by the company to those having thousands of one-piece to make which are exceptionally large at one end, small in diameter, but long and light.

A view of this magazine is shown in the accompanying illustration. When it is attached to the machine, the bracket



Special Rotary Magazine Attachment for Cleveland Automatics

A rests on top of one of the bed arms, and the hole located in position *B*, is in line with one of the turret holes. The collar *C* fits on the cam-shaft, and a conveyor *D* is held in the turret of the machine. Directly back of the hole in position *E*, there is a spring plunger which enters the rear of the hole at this point and serves to hold the drum rigidly with

the supporting bracket *A*. This plunger, however, allows drum *F* to be indexed to the next hole when pressure is applied to one of the pins projecting from the periphery of the drum.

In operation, the pieces of work are placed in the bushings which are inserted in the face of the drum *F*. When the conveyor is carried forward by the turret, it removes the piece from bushing *B*, and when the turret recedes, the pin *H* in the collar *C* engages pin *G*, thus indexing the drum to the next position. When this magazine is attached to an automatic it is simply necessary to keep it filled with work, and one man or boy can easily attend to six machines. As is evident, the mechanism is exceedingly simple, and this is always a reliable guarantee against trouble of any kind.

PRYIBIL SELF-BALANCING ELLIPTICAL CHUCK

The elliptical chuck is an old piece of apparatus, made in a number of different designs by different manufacturers. It finds a limited application in machine work, and a more extensive one in wood-working and metal spinning. In woodworking it is used for such operations as the turning of oval picture and mirror frames, ornamentations, etc.; the large variety of elliptical and oval shapes in sheet metal requires its use for metal spinning. These more common uses of the device require high speeds. In this respect the elliptical chuck has hitherto been defective, owing to the fact that the

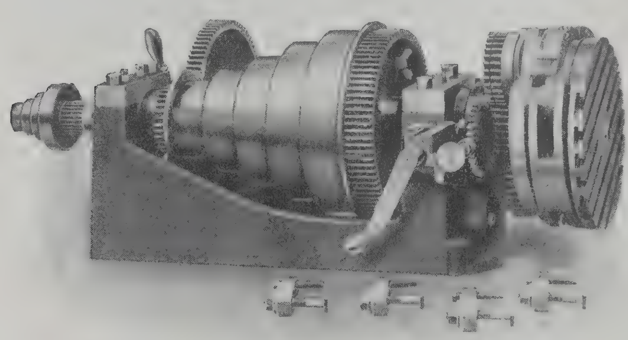


Fig. 1. Pryibil Self-balancing Chuck, adapted to Heavy Work

reciprocating parts are unbalanced, causing excessive and dangerous vibration if it were attempted to run at a rate of speed such as would be used for circular work of a corresponding character. In the chuck herewith illustrated and described, made by P. Pryibil, 512-524 West 41st St., New York City, the reciprocating parts have been balanced so that the

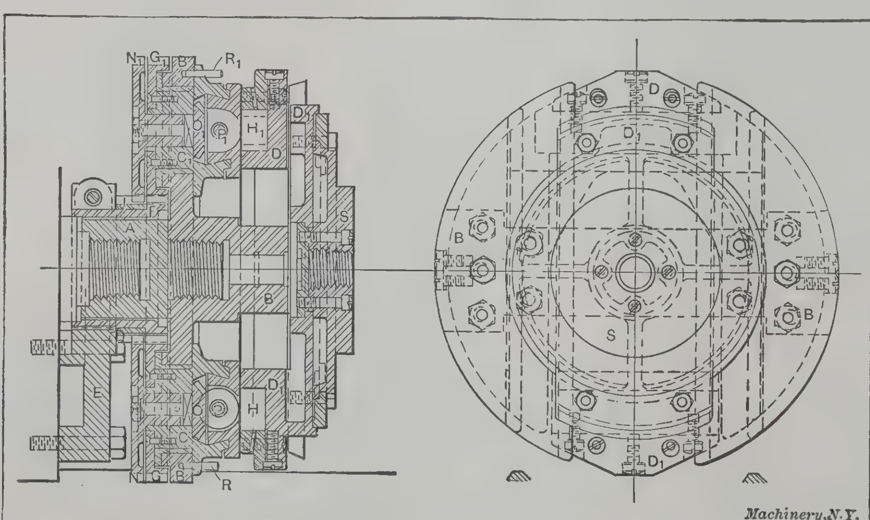


Fig. 2. Section and Face View of Chuck, showing Construction

chuck can run smoothly at high speeds. This greatly increases its capacity, giving a large return in product per hour of work, for the extra mechanism employed.

Fig. 1 shows the heavier form of chuck used for metal turning, attached to an engine lathe head-stock; Figs. 2 and 3 show details of the construction. A false nose *A* is screwed onto the lathe spindle to extend the latter sufficiently to bring the chuck clear of the head-stock. Screwed onto this false nose, and therefore revolving with the spindle, is the main frame *B* of the chuck. This main frame is in the form of a cross

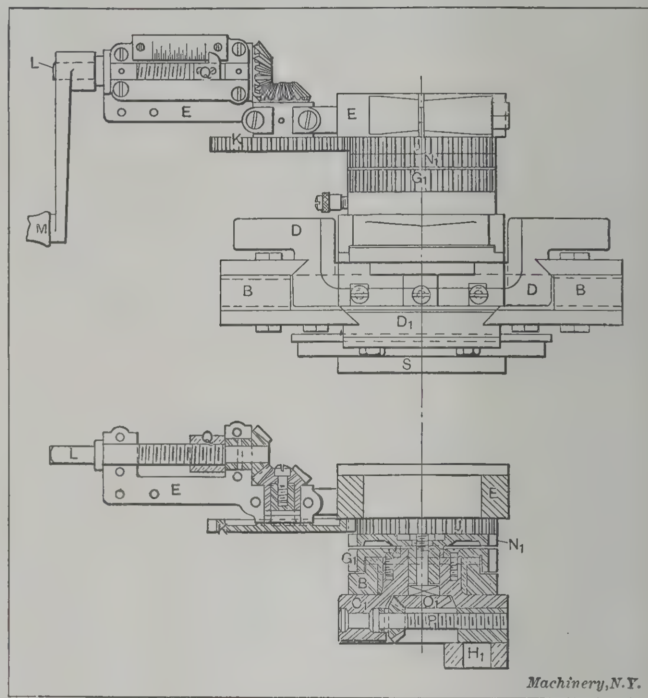


Fig. 3. Top View and Section through Adjusting Mechanism

arm (this construction is not very clearly shown in the engravings) whose vertical arms carry bearings for revolving cranks at *C* and C_1, while the horizontal arms, seen in Fig. 3, are provided with gibs for the two reciprocating slides, one in back at *D* and the other in front at D_1.

The bracket *E*, bolted to the face of the head-stock, has keyed to it a spur gear *F*, concentric with the spindle. Cranks *C* and C_1 have screwed and doweled to them gears *G* and G_1, meshing with this gear *F*. Crank pins at *H* and H_1 (so mounted in cranks *C* and C_1 as to give an adjustable stroke as will be described) are pivoted in square blocks fitted to slots in slides *D* and D_1. It will thus be seen that, as the spindle of the lathe, false nose *A*, and body *B* revolve together, gears *G* and G_1 will roll around on stationary gear *F*, revolving cranks *C* and C_1, and thus causing, through crank pins *H* and H_1, the reciprocating of slides *D* and D_1. Slide D_1 travels back and forth across the face of the chuck, carrying the work, which thus receives a proper movement for elliptical turning. Slide *D*, on the other hand, on the backside of the chuck, moves always in opposite directions to slide D_1. Owing to the fact that these two slides are practically equal in weight, they balance each other in their movement, and permit the rotating of the chuck at a high rate of speed. This is the important innovation in the design.

Adjustments are provided for all the important sliding bearings, such as those for slides *D* and D_1 in body *B*, and for the squared blocks *H* and H_1 in slide *C*. The face-plate *S*, which is mounted on slide D_1 can be rotated and clamped in any position to bring the major axis of the ellipse in any required relation with the work being operated on.

There is another feature which adds greatly to the usefulness of this tool—the provision made for adjusting the eccentricity of the movement while the chuck is revolving. By this means, the difference between the major and minor axes of the ellipse being turned, can be adjusted as required, without stopping the work and without measurement. On the hub of stationary gear *F* is mounted a gear *J* (see Fig. 3), mesh-

ing with a gear K, having a bearing in bracket E. Bevel gears connect this with a shaft and crank L and M, by means of which gear J may be revolved. Gears N and N_1, which also mesh with J, are keyed to bevel gears O and O_1, which in turn operate adjusting screws P and P_1, which are threaded into the adjustable crank pins H and H_1.

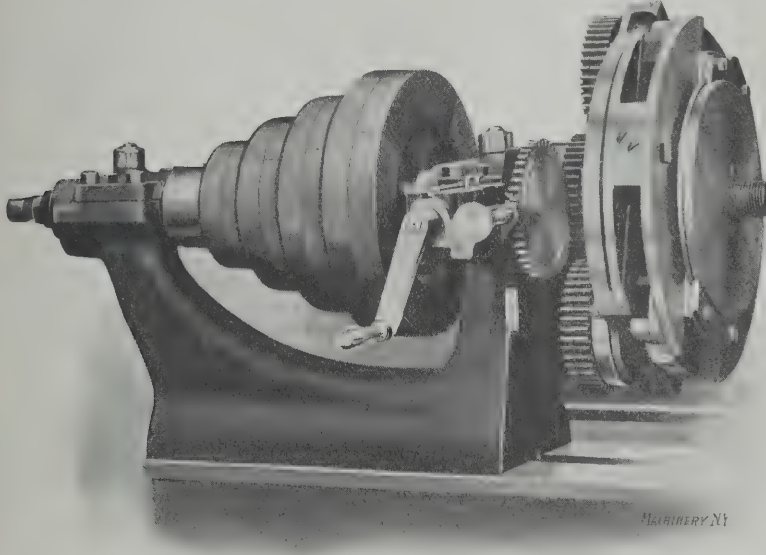


Fig. 4. Lighter Design of Chuck, used for Wood Working and Metal Spinning

It will be seen that with J and F both fixed in position, gears N and G, and N_1 and G_1, will rotate together without any movement relative to each other, so that the adjusting screws P and P_1 will be stationary and the adjustment of crank pins H and H_1 will remain unchanged. When, however, gear J is revolved by crank M, N is moved with reference to G, and N_1 with reference to G_1, so that adjusting screws P and P_1 are rotated and the throw of crank pins H and H_1 is increased or diminished. By this means the difference between the major and minor axes of the ellipse being turned is increased or diminished at will. As may be plainly seen, it makes no difference whether or not the machine is running, for while gears N and G are running around gears J and F, the adjustment can be made either way.

Adjusting shaft L is threaded and is provided with a nut Q, having an index finger reading the amount of eccentricity on a fixed scale. This is a great convenience in setting up the

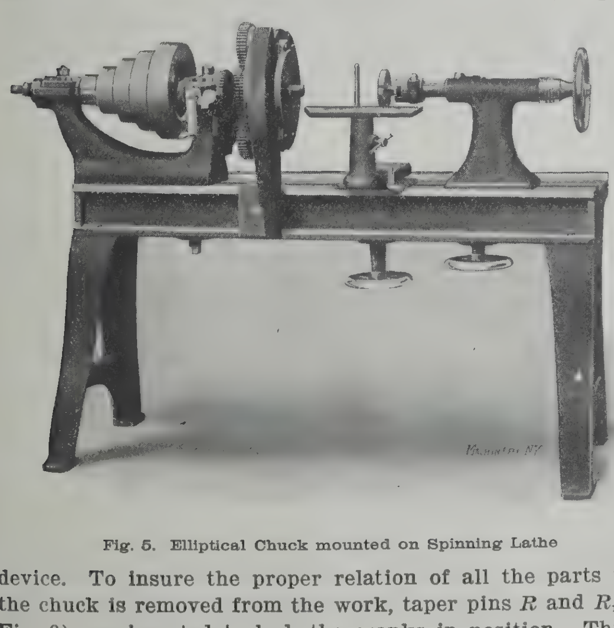


Fig. 5. Elliptical Chuck mounted on Spinning Lathe

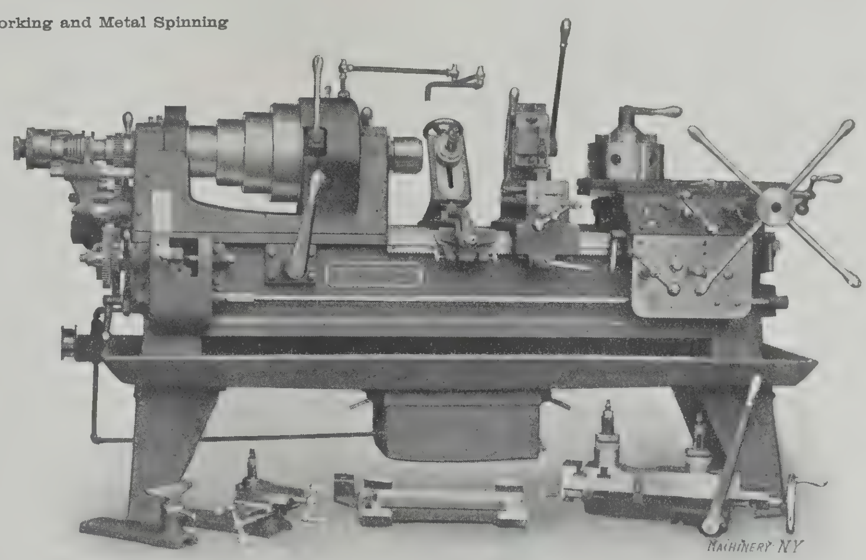
device. To insure the proper relation of all the parts when the chuck is removed from the work, taper pins R and R_1 (see Fig. 2) are inserted to lock the cranks in position. This insures the proper action of the chuck when it is again mounted in place on the machine.

Fig. 4 shows a larger and lighter form of this fixture, operating on the same principle used for wood work and metal spinning. It will be noticed in both Figs. 1 and 4 that a positive means of locking is provided, by a bolt entering the spaces between the teeth of gear K, so that no accidental change of adjustment is possible. In Fig. 5, this interesting device is shown attached to a metal spinning lathe, provided with a proper guard for protecting the workman from the mechanism.

DRESES 20-INCH FULL UNIVERSAL "MONITOR" LATHE

The "Monitor" lathe herewith illustrated and described is built by the Dreses Machine Tool Co., Cincinnati, O. It is designed for general brass and similar work of a heavy character, made from castings, forgings and stock. It is provided with such adjustments as make it possible to manufacture, without special tools, many pieces for which it would not pay to equip the ordinary machine of this type.

The turret carriage feed mechanism is similar in design to that of the standard engine lathe. A positive geared feed is provided, with a quick gear change box, giving eight variations.



A Monitor Lathe with Universal Adjustments for a Wide Range of Work

These changes cover the ordinary standard pipe threads, as well as giving suitable turning and boring feeds. Provision is made for obtaining other feeds and pitches by the use of change gears.

The turret slide is in two parts, with a taper dove-tail plate interposed, on the lower side of which is carried a shoe swivel sliding on the bar of the taper attachment. The latter is shown dismounted from the machine, lying on the floor under the center of the bed. This, when in use, slides on the inside of the bed and is held in place by a suitable clamping bolt. It can be readily removed and no special provisions are necessary in the design of the bed for holding it. By its use, inside or outside, taper or straight threads, can be chased by a tool in the turret without the use of a tap or die.

The upper section of the intermediate dove-tail plate has a screw with a ball crank for cross feeding by hand. Positive stops are provided for setting the turret holes in alignment with the spindle. The turret slide is provided with a pilot wheel for rapid movement, and with a screw for finer adjustments. The pilot wheel may be removed from its stem so as to be out of the way when the screw feed is in constant use. The turret is adjustable for wear on its seat. The locking bolt withdraws at the return movement of the top slide, making the rotation of the turret semi-automatic.

The head-stock is provided with carefully enclosed friction

back gears, with clutches of the toggle joint type, so designed that the whole operating mechanism can be put in place or removed without taking out the spindle. The automatic chuck is operated with the handle shown below the cone pulley.

Various forms of cross-slides, rests, etc., are provided, as shown in the illustration, fitting the machine for a wide range of work. The chasing bar has a yielding follower holder, which maintains contact with the leader when chasing taper work. The taper attachment for the chasing bar is provided with knurled screws for minute adjustment. A vertical forming rest is also shown in place on the bed. The cutting-off rest is shown on the floor at the right, and hand and slide rests at the left. The taper attachment has already been mentioned.

This lathe is furnished with a pan, oil reservoir, pump and piping, adapting it for iron and steel as well as brass. It swings 20½ inches over the V's, has a bed 6 feet 6 inches long, and weighs about 3,600 pounds.

CUTTER GRINDING HEAD FOR B. & S. UNIVERSAL GRINDING MACHINES

The cutter holding head and its attachments, shown herewith, is made by the Brown & Sharpe Mfg. Co., of Providence, R. I. It is similar in design to the corresponding parts pro-

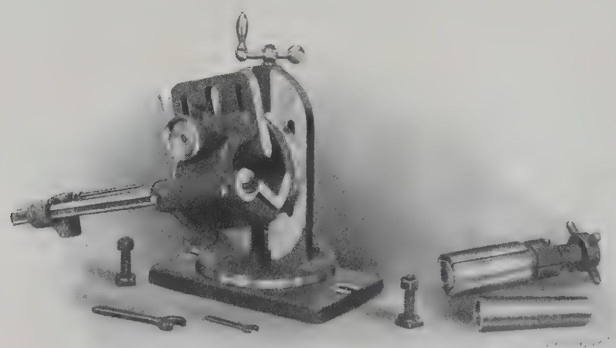


Fig. 1. Universal Cutter Sharpening Head and Equipment

vided for their No. 13 universal and tool grinding machine, but is arranged to be used on any of the universal grinding machines made by the builders. The device should, therefore, prove a great convenience in shops whose requirements are so small as to make the purchase of a special cutter and reamer grinding machine inadvisable, but whose management still desires to obtain the benefit of the economical production only possible with milling cutters kept in proper cutting condition.

The attachment consists principally of a swivel vertical column, upon the slide of which a swivel head for supporting

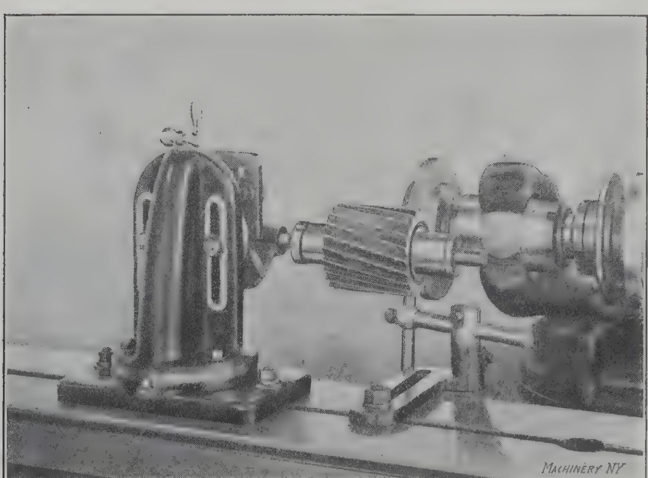


Fig. 2. Spiral Milling Cutter being sharpened on Cutter Bar

the work is fastened. The vertical column is mounted on the base-plate which, in turn, is securely fastened to the table by means of a clamping bolt at each end, passing through slots in the base casting.

The base plate is of solid construction and has a large bearing surface upon the table, thus insuring a rigid support for the vertical column. It is made in two styles, one of which has a tongue on the under side to fit the T-slot in the table of universal machines; the other has a longitudinal V-way that fits over a way of like design on the table of the No. 13

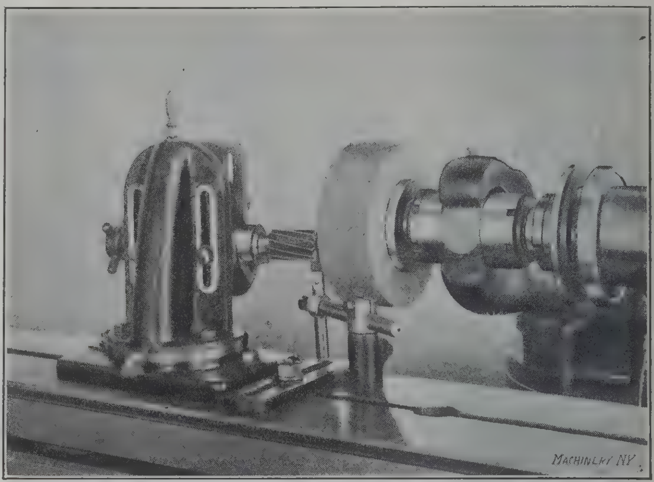


Fig. 3. The Taper Shank Mill Sleeve in Use

universal and tool grinding machine. In either case the alignment of the head, with relation to that of the table, is correctly and simply maintained. The column swivels in a horizontal plane and may be set at any angle with the table. A dial graduated to degrees, encircling the entire circumference of the base, facilitates quick adjustment to any desired angle. Two bolts, which pass through the base and slide in circular slots in the base plate, serve to securely clamp the column.

In the convenience and adaptability of the work head are found the features of the attachment. It is simply and compactly constructed and has a large bearing surface on the vertical column, thus making it fully capable of resisting vibrations due to the action of the wheel on any work within

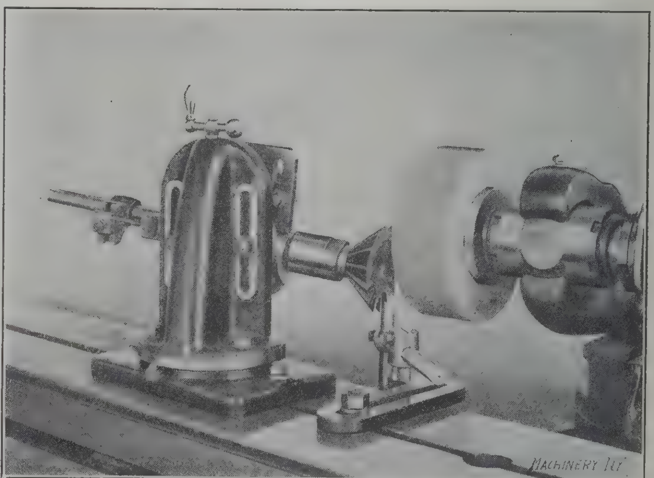


Fig. 4. Grinding the End Teeth of an Angular Cutter, supported in the Vise

the range of the attachment. The head swivels in a vertical plane and may be clamped at any angle up to 90 degrees either side of zero, its position being indicated by a dial graduated to degrees on the circumference of the base. The clamping bolts pass through circular slots in the head casting and vertical slots in that of the column. Provision is made for a vertical adjustment of 4 inches, by means of a ball crank at the top of the elevating screw. With the head at its extreme height, work up to 16 inches in diameter will swing over the table; by turning the head at right angles, light work up to 24 inches in diameter can be accommodated.

Two methods of holding work are provided; milling cutters being clamped directly by their shanks or arbors in a V-shaped vise, while work requiring sliding shells is supported on a rod known as the cutter bar. The vise is rigid and readily adaptable to many varieties of work. The lower jaw consists of a heavy V-shaped trough in which the shank or arbor of the work is placed. The upper jaw pivots, and is adjusted by

means of a hand clamp screw. A long drop-back rest is carried by the upper jaw. To fasten work, this rest is lowered until it touches the piece and is clamped in this position. Then, by simply adjusting the hand clamp wheel the drop back rest is securely fastened upon the piece. An adjustable center rod is provided for supporting and taking the end thrust of work having a tapered shank; it may also be used for taking the end thrust of centered pieces that are not clamped solidly in the vise while grinding.

The cutter bar is made of steel, ¾ inch in diameter, and has a flat side for clamping screws to seat upon without injuring the working surface. It is supported in bearings in the work head casting and, in addition to holding work to be ground, serves as an arbor for the upper portion of the vise to pivot upon. It can be adjusted to any length and clamped by means of set screws. An additional cutter bar ⅜ inch in diameter can be furnished when so desired.

A device known as a taper shank mill sleeve is furnished with the universal head and is particularly useful in grinding work having taper shanks, such as end mills, etc. It consists of an outer sleeve that can be rigidly clamped in the vise, and a taper bushing in which the work is held. The bushing is free to turn in the sleeve, but is held positively against the end of the sleeve by a spring. A handle fastened to the outer end of the bushing serves to hold the work against the tooth rest as well as for indexing. Two taper bushings are furnished with the attachment; one No. 7 and the other No. 9.

By the employment of this device, it will be seen, reamers, milling cutters, counterbores, countersinks and a large variety of other cutting tools can be quickly and accurately sharpened. The attachment is simple in design, convenient in operation, and is easily removed and placed in position.

COLBURN FLOATING REAMER HOLDER

The tool herewith illustrated and described is intended for holding reamers in turret machines, particularly vertical boring and turning machines with turret heads, when it is necessary to so support the reamer that it will find its own center in the work. In other words, the tool is a floating holder. It is impossible to depend on having the turret near enough in line or the reamer straight enough to permit holding it rigidly for a power operation. Floating reamer holders

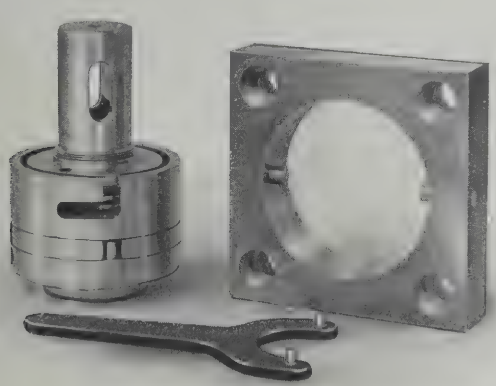


Fig. 1. Colburn Floating Reamer Holder

have been made for many years in individual shops for home use. The design here described is intended to make a commercial product of the device, the object being to provide a construction which would be thoroughly practical and satisfactory in every particular, and which could at the same time be readily adapted to machines of any make.

In Fig. 1 the tool is shown assembled; Fig. 2 shows it separated into its component parts; Fig. 3 shows it in use in the machine, and Fig. 4 is a detailed drawing. The construction of the tool will perhaps be best understood by referring to Figs. 2 and 4.

The reamer, which may be of the solid or shell, adjustable or non-adjustable styles, is mounted by its taper shank in socket E. The latter is driven from sleeve C by a universal coupling arrangement. This consists of a collar F, interposed between C and E, and provided with slots closely engaging pins G which are fast in E, and pins G_1 which are fast in C. E and the reamer which it contains are thus allowed to find their own centers with relation to the work, there being no cylindrical fit between socket E and sleeve C. At the same time a strong and direct drive is provided. This coupling will be seen to be an interesting use of a well-known mechanical principle. To keep the faces of C, F and E tightly pressed

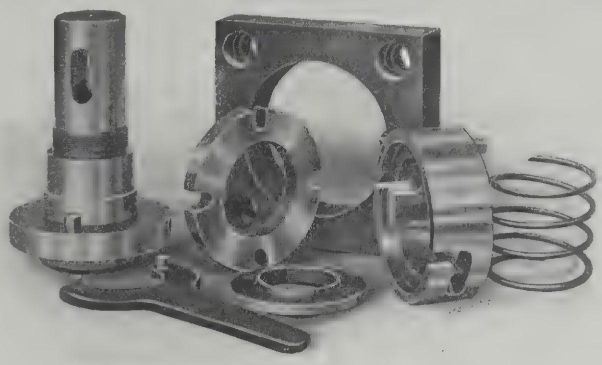


Fig. 2. Reamer Holder separated into its Component Parts

together, nut I is threaded onto the socket, compressing spring H against its seat in C. The spring may be adjusted to be strong enough to overcome the weight of the reamer and its shank, and to keep the parts of the holder tightly pressed together.

The socket and sleeve are held in a base A by a bayonet lock arrangement, which permits their instantaneous insertion or removal, as may be required. The bayonet grooves

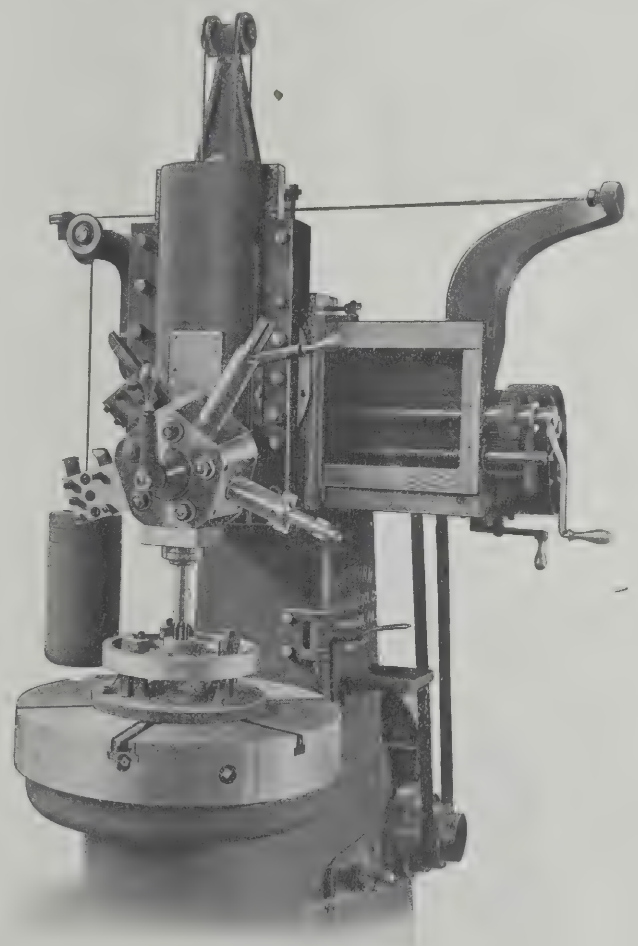


Fig. 3. Reamer Holder in Use in Vertical Boring Mill

are formed in sleeve C, and they are engaged by pins B driven into A as clearly shown in the engraving. Base A is the only member which has to be fitted to the turret; this will be provided by the makers, the Colburn Machine Tool Co., Franklin, Pa., for any dimensions to agree with the machine on which it is to be used.

The advantage of this device may be summed up as follows. It is a commercial product made on a manufacturing basis after a carefully thought out design, instead of being a home-

made and make-shift contrivance. It will fit any make or style of reamer, it only being necessary to provide a shank having the usual Morse taper. It can be used on any make or style of boring mill having a turret with flat sides. It will hold the reamer parallel with the axis of rotation at the same time that it permits it to center itself.

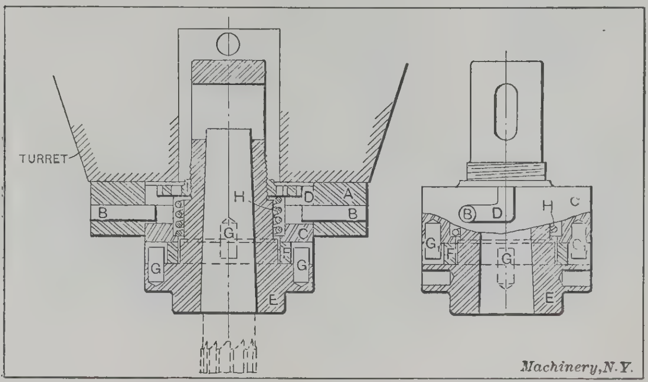


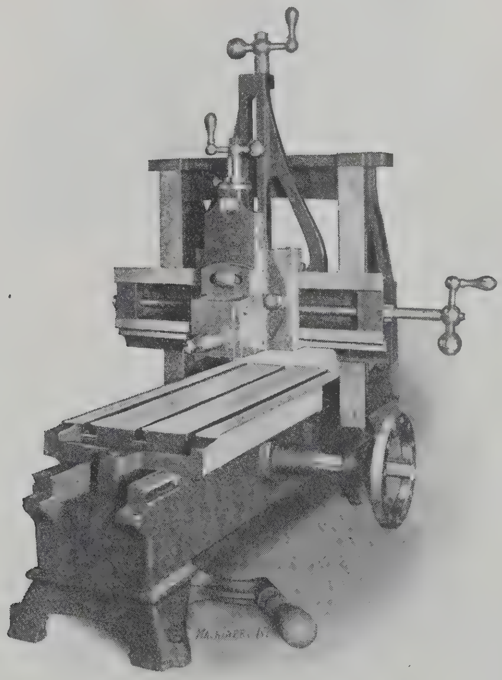
Fig. 4. Details of the Construction

These holders are made in two sizes. The No. 1 has a No. 4 Morse taper socket capable of holding reamers up to 3 inches in diameter; the No. 2 size has a No. 5 Morse taper socket, and will carry reamers up to 4 inches in diameter.

SCHNEIDER HAND-OPERATED METAL PLANER

The illustration shows a metal planer of small size, built by the Schneider Machine Tool Co., 20 East 9th St., Cincinnati, O. This planer is built for hand-operation only, so is especially fitted for model, experimental and tool work.

The illustration shows that the machine is built on the general lines of the heavier power-driven planers. It is provided with a modification of the cross-rail elevating mechanism, however, which is more appropriate to a machine of this size. A slide or frame attached to the back side of the cross-rail extends upward above the top of the housings, where it forms a bearing for a single elevating screw. A slot cut in this frame is guided by a bearing block attached to the housing tie-piece. By this means the rail is kept accurately in alignment with the surface of the table even though but one screw is used instead of two as usual.



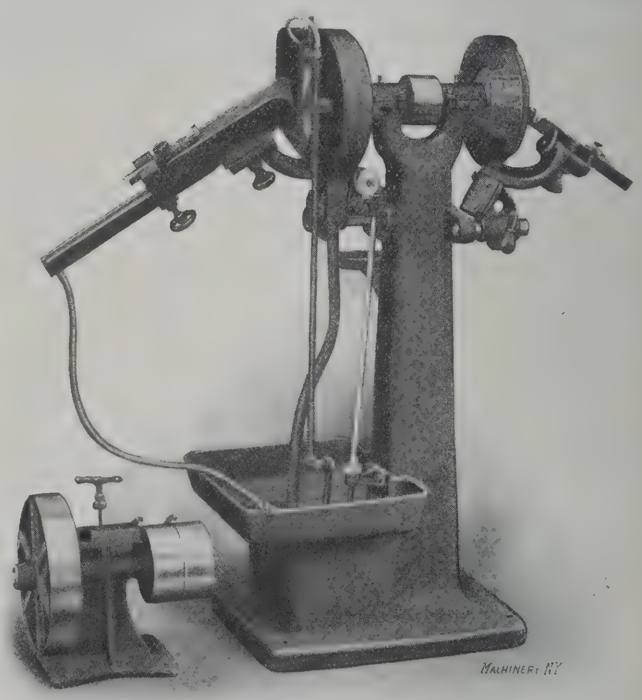
Hand-operated Planer for Tool, Model and Experimental Work

A rack and gear are used as in larger planers for reciprocating the table; the gear is mounted directly on the shaft to which the hand-crank is attached. The hand-wheel on this shaft, as shown, is provided with a series of holes into any one of which a locating pin on the crank may be inserted, thus permitting the latter to be set in any position that is convenient for the cut on the table. It also permits rapid change in position whenever required by the work.

The machine is substantially built to secure the stiffness required for accurate work. The bed has flat ways and is provided with oil channels and pockets to prevent the lubricant from running down outside or inside of the bed. The table takes in 10 inches between the housings, and 8½ inches under the cross-rail. The rack is 24 inches long. An automatic cross-feed will be furnished if desired.

IMPROVEMENTS IN THE "YANKEE" DRILL GRINDER

An improved "Yankee" drill grinder has lately been placed on the market by the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich. Some difficulty has been experienced in previous constructions in regard to the handling of small drills in a holder of sufficient capacity to take care of the large sizes of drills which are in more common use. In the machine now placed on the market this difficulty has been eliminated, and the machine combines a capacity for handling large sized drills with the greatest convenience in grinding small drills. A large holder is furnished for wet grinding of large drills, having a maximum normal capacity for 2¼-inch diameter drills with a minimum capacity for ⅛-inch drills. A smaller holder, however, is also provided in which, with greatly increased convenience, drills from a maximum of ⅝-inch diameter down to a minimum of No. 60 drill gage size can be ground. A finer grade of emery wheel is provided for the smaller drills, and, as seen in the accompanying illustration, two operators can be working, one on each of the two holders, without interfering with each other. Both holders embody the regular "New Yankee" construction, by which the time-consuming preliminary adjustments are avoided by means of the angle of the V-shaped groove or trough which automatically locates each different size of drill in the right position for grinding.

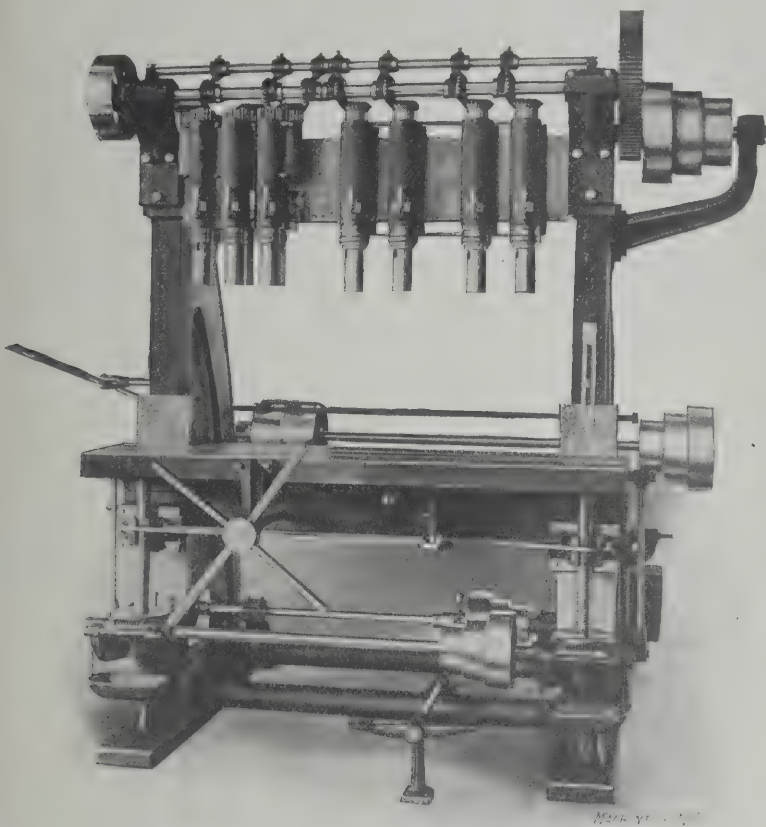


"New Yankee" Drill Grinder with Improved Drill Holder for Smaller Sizes; built by the Wilmarth & Morman Co., Grand Rapids, Mich.

The clearance can be adjusted when required, so as to provide for either the small amount of clearance desirable for working in hard steel, or the much greater clearance necessary for drilling softer metals. The normal clearance, however, is maintained for drills of different sizes for ordinary service, without any adjustment being required on the part of the operator. The machine shown in the accompanying engraving is designated by the makers as the style "WPL." Its general design, outside of the features referred to, is entirely along the same lines as that of the well-known regular type of the "New Yankee" drill grinders.

ANDREW AUTOMATIC CYLINDER BORING MACHINE

M. L. Andrew & Co., of Cincinnati, O., make a multiple drill of the double housing and cross-rail type, which we have before illustrated in a variety of designs for a variety of applications. (See, for instance, the department of New Machinery and Tools in the November, 1907, and the April and November, 1908, numbers of MACHINERY.) Still another modification of this machine is herewith illustrated.



Andrew Multiple Spindle Drill Modified for Cylinder Boring

This particular design is intended for the boring operations on automobile cylinders. The multiple spindles are divided into two groups. The three shown at the left are permanently gibbed and bolted to the cross-rail, in such a position that they can bore the four valve seat chambers and the two spark plug holes, in the time required to finish one hole on the single-spindle machine. The four spindles at the right of the cross-rail are gibbed to the rail, but are adjustable on their mounting. In the arrangement shown, they are tied together by gages at the top and bottom to preserve definite center distance. These may be used for boring the cylinders themselves, or for boring angle holes for cylinder plugs.

The general design of the machine is the same as those we have previously illustrated. The spindles are of high carbon steel, running in phosphor-bronze bearings with ball thrust collars. They will be provided with either No. 4 or No. 5 Morse taper sockets as desired. The table is fed upward with steel feed-screws, operated by carefully-made worm-gearing. The feed-screw nuts are of phosphor-bronze, opened and closed by a hand-lever on the front of the table; the feed throw-out is automatic. The pilot-wheel controls the rapid movement or adjustment of the feed. The table itself is made extra heavy, is provided with T-slots, and is counterbalanced. The three spindle speeds are designed to be suited to the different diameters of holes in the work in automobile cylinder operations.

GANG RADIAL DRILLING MACHINE

The radial drill made by the Wm. E. Gang Co., Cincinnati, O., has been redesigned, as shown in the engraving.

The general design of this radial drill is well known. The spindle is driven from a horizontal shaft which passes through the swinging column, where it is connected by gearing with the vertical drive-shaft. This construction gives much more direct drive than usual. Another distinctive feature of the machine is the placing of the power-elevating mechanism on the arm instead of at the top of the column. The screw is thus a stationary one acted on by a revolving nut.

In the new design, the particular point of interest is a new spindle drive mechanism: *A*, in Fig. 2, is the horizontal driving shaft, passing through the column as described. This shaft has keyed to it a pinion *B*. driving bevel gears *C* and *D* in opposite directions. These latter revolve loosely on the shaft, and are provided with internal seats against which friction rings may be expanded, so that either of them can be connected with shaft *F*. This double friction clutch is operated by lever *N* through collar *E*. By this means the spindle is quickly reversed in either direction. Spur gear *G* is solid with shaft *F*, and spur gear *I* is keyed to it. These mesh with gears *H* and *J* respectively, which run loose on sleeve *L*. Sliding jaw clutch *K*, controlled by lever *O*, may be operated to engage either one of these with the shaft. This corresponds to the usual back gear provision, giving eight changes of speed with the cone pulley drive, or twelve with the speed box.

An important point in the drive thus described is the fact that the friction clutches for reversing operate between the high-speed shafts *A* and *F*—that is to say, the back gears are placed between the clutches and the spindle. By this means they are relieved of the excessive strain that would be thrown on them in such work as heavy tapping which requires the reversal of the

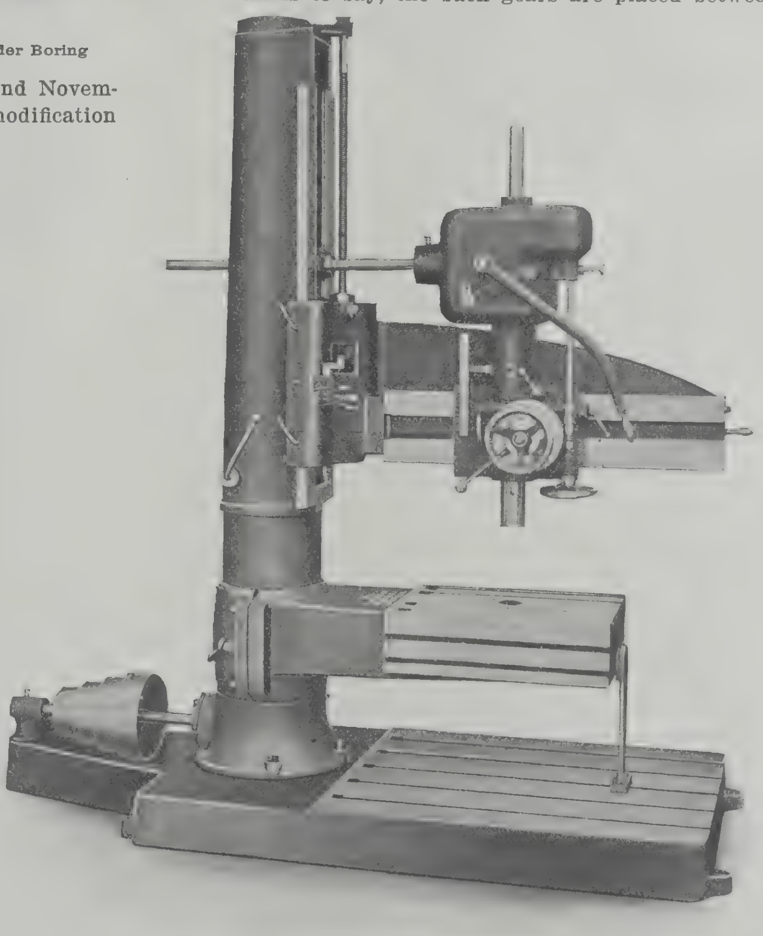


Fig. 1. Gang Radial Drilling and Tapping Machine

spindle while the tap is lodged in the work. The friction clutch operates without shock or jar.

Another important improvement is the depth gage and automatic stop. The gage is shown at *R*, and the adjustable tripping dog and pointer at *S*. The point of novelty lies in the fact that the graduated scale, instead of being on the spindle and moving with it, is attached in a stationary position on the head. The adjustable dog and pointer is clamped

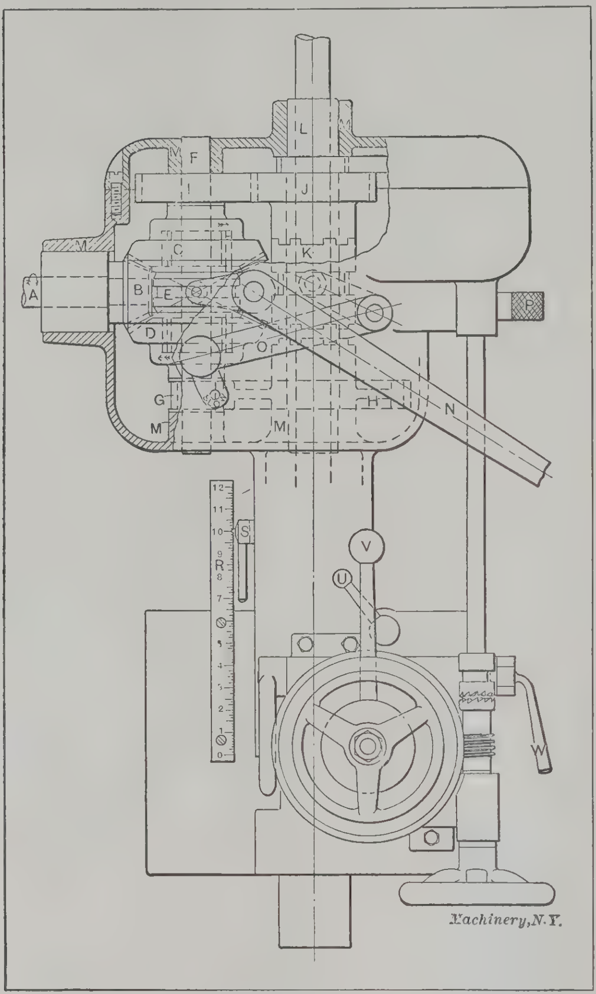


Fig. 2. The Improved Spindle Drive of the Gang Drill

in any required position by a bolt seated in a T-slot in the spindle sleeve. Thus arranged, with the zero point at the lower end of the graduated scale and in a fixed position, all the operator has to do in preparing to drill or counterbore a hole to a given depth is to bring the tool down onto the surface of the work, set the pointer on dog *S* opposite the graduations on the scale corresponding to the required depth, tighten the pointer and start the feed. When the pointer gets to zero, the feed will be knocked out automatically, and the spindle can travel no further. All depths are read from zero.

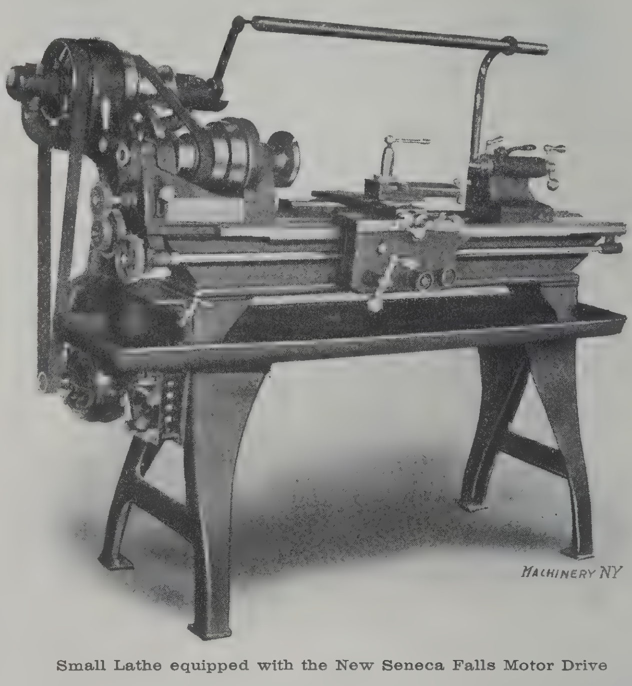
Four rates of feed are provided on this machine—0.008, 0.011, 0.014 and 0.017 inch per revolution of the spindle. The changes are made by turning knurled knob *P*. The feed is taken from a positive connection with gear *J*, through the change mechanism and a worm and worm-gear connection for the rack-pinion. The worm-gear drives the rack-pinion through a friction clutch, operated by quick return lever *V*. Lever *W* operates the positive clutch shown, which can be disengaged when it is desired to use a hand worm feed.

The head is firmly gibbed on the radial arm, and may be adjusted in and out by rack and pinion actuated by a handwheel. It is locked in position by clamp screw and lever *U*. It will be noted that, in accordance with their usual practice, the builders have enclosed all the gearing, thereby protecting both the operator and the mechanism from injury. This construction also minimizes the number of bolted-on bearings, and gives a pleasing appearance of neatness and simplicity to the design.

This machine will be furnished with a square, round, plain swiveling, worm swiveling, round tilting, square box or square tilting table. The square box form of table is shown in the illustration.

SENECA FALLS MOTOR DRIVE FOR "STAR" LATHES

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has recently brought out a new type of motor drive for its 9- and 11-inch "Star" lathes. This new arrangement is shown in the accompanying illustration. The advantage of this type of motor drive over other methods employed is in its adaptability to the varying conditions imposed by the users of small engine lathes, as they ask for motors for all kinds of electric current. For this reason the drive has been designed so as to use any kind of constant or variable speed motor. Preferably, it should be non-reversible, and with a speed of 1,000 to 2,000 revolutions per minute. This drive may be easily attached to a lathe. A pulley on the motor of the proper size transmits the power by belt to a countershaft pulley that runs constantly in one direction. A belt is also used to transmit motion from the countershaft to the lathe spindle. Means are provided for quickly tightening these belts so that they can be kept at the proper tension until worn out, without shortening them. Experience has proved that this method of driving small lathes has advantages over rigid gearing and chain belt drives, as the use of belts will often prevent damage to both motor and lathe. Starting, stopping, and reversing the rotation of the lathe spindle is controlled by a shifting bar placed horizontally above the lathe within easy reach of the operator. When this bar is in the central postion, the lathe is stationary. By shifting it to the left, a forward motion is imparted to the lathe spindle, while shifting it to the right gives a reverse movement.



Small Lathe equipped with the New Seneca Falls Motor Drive

The driving mechanism consists of friction clutches and gears for reversing the motion, which are encased and run in a bath of oil. This mechanism is simple in its construction and it is not liable to damage or disarrangement. The bearings are thoroughly lubricated by oil rings.

LELAND SENSITIVE MULTI-SPINDLE DRILL

The accompanying half-tone illustrations show a front and rear view of a four-spindle sensitive drill press built by W. H. Leland & Co., Worcester, Mass. This machine is known as the Leland "sensible" sensitive drill press, and in its design several new and interesting features have been introduced. Chief among these features are the arrangement for obtaining proper belt tension, the variable lever ratchet feed for the spindle, the arrangement of positive spindle stops, and the general design of the frame and the table, which makes it possible to obtain the maximum of strength without giving the machine a clumsy or unattractive appearance. The ma-

chine, however, is very heavy in comparison with the general type of these machines, it being about 250 pounds heavier than some other machines of its class. This additional metal has been distributed with care, so as to put it in such places where it will render the machine more efficient.

As will be seen in Fig. 2, the machine is provided with loose and fast pulley drive for the main driving shaft in the rear. The loose pulley is made smaller than the tight, to relieve the tension on the belt when the machine is not running. On the main driving shaft are placed the four-step cone pulleys from which the power is transmitted to the upper horizontal driving shafts and from there in the usual manner to the vertical spindles. The arrangement for obtaining the proper belt tension on the vertical belts between the cone pulleys as well as on the horizontal belts from the pulleys which drive the vertical spindles, is of especial interest. As shown in Fig. 2 the frame, or, as it has been commonly called, the "goose-neck," of the individual drills, is of a triangular construction, that is, it is provided with two braces in the back so placed that the belt tension from the two belts will largely strain these braces as compression members, thus insuring the maximum strength.

At the back where these two braces join, the frame is provided with a slot, the sides of which may be brought together or tightened by means of the handle shown in Fig. 2, immediately below the pulley transmitting power to the vertical spindle. The bearings for the upper cone pulleys and the pulley driving the spindle are held in this slot, and are supported by a screw which enters into an elongated nut provided with a hand-wheel, as shown, between the two braces. The end of the elongated nut rests in a socket in the back of the main column of the frame or goose-neck. When the binding handle mentioned is loosened and the hand-wheel operated, the screw is moved either out or in, according to the direction of rotation of the wheel, and as the bearings for the cone and driving pulleys are directly connected with the screw, they will consequently move outward or inward, as the case may be. Owing to the fact that the thrust on the screw is taken in a direction such that the axis of the screw bisects the angle between the vertical and horizontal belt pulls, the tension on both of the belts will adjust itself automatically so that it will be of the same amount in each, this being possible on account of the socket joint in the main column which takes the thrust. When the bearings have taken their proper location, the bracket carrying them is clamped in position in the slot in the back of the frame, by means of the handle already referred to. This means for tightening the belts is both convenient and efficient. It is quickly operated and it equalizes the tension on both belts automatically. When small holes are drilled and less belt tension is required, the belts may be slackened. When heavier drilling is to be done, it is but a moment's work to again get heavier tension on the belts.

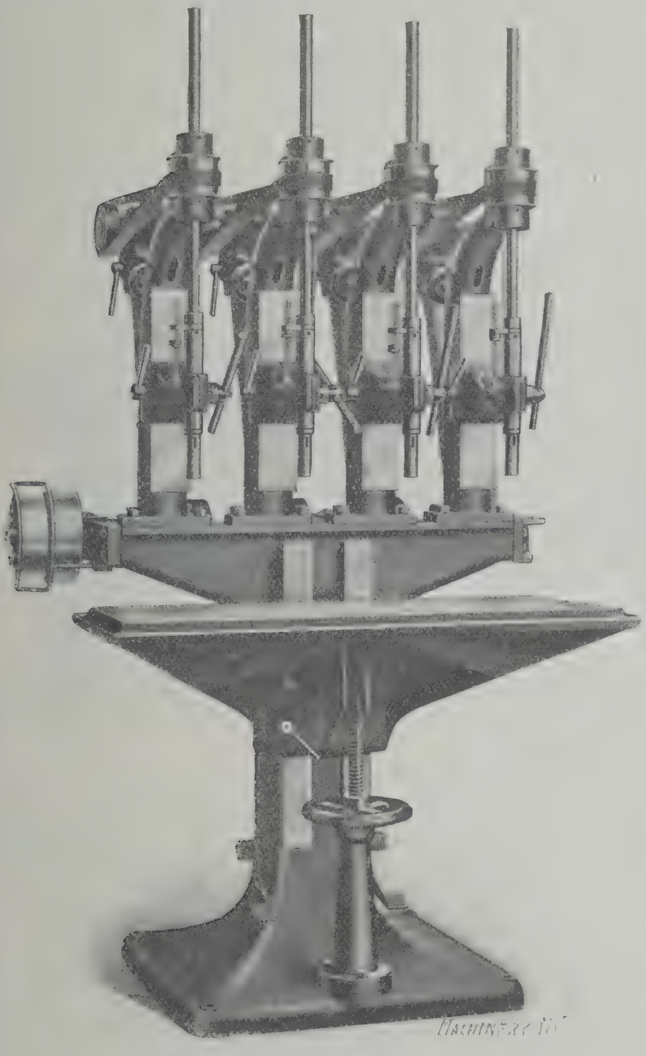


Fig. 1. Sensitive Four-spindle Drill, built by W. H. Leland & Co., Worcester, Mass.

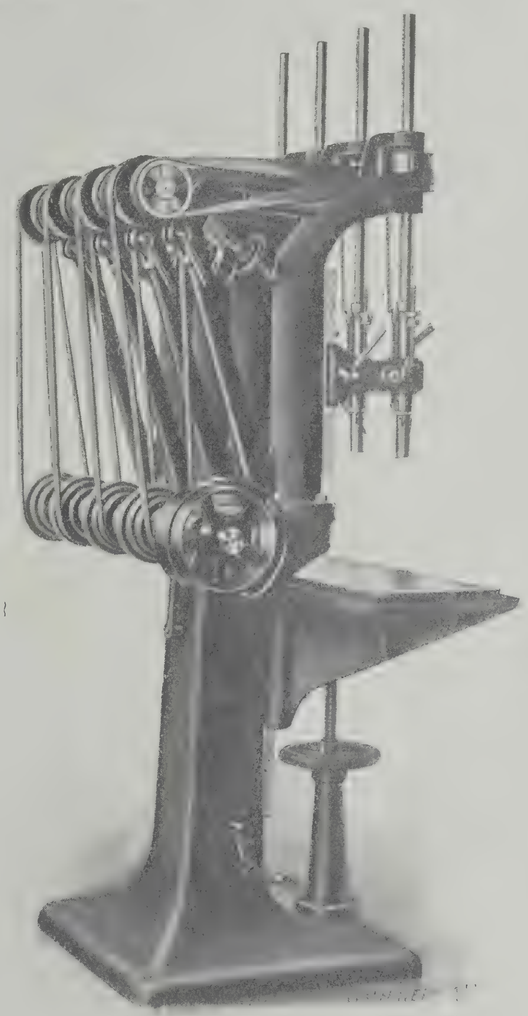


Fig. 2. Rear View of Leland Sensitive Drill, showing Driving Arrangement

The main driving shaft is provided with a bearing in the center, as well as at each end, in order to maintain perfect alignment; and at the top of the spindle, a bearing is provided at each end of the spindle pulley. It will be seen in Fig. 1 that apparently the pulley on the vertical spindle is wider than necessary. As a matter of fact, this pulley is actually a drum, and the extra width is required on account of the swinging action of the driving pulley when adjusted for belt tension. The width of the belts used is $1\frac{1}{4}$ inch, but the spindle pulley is more than twice the width of the belt. This permits the belt to assume a normal position on the pulley when the shaft in the back is moved either up or down, as required.

The machine is built in two styles, one having all ball-bearings, while the other is provided with bearings with inserted bushings, these latter being made of Parsons white brass. All the bearings on the machine when provided with inserted

bushings are ring-oiled with the exception of the vertical bearings, which are equipped with felt storage for the oil. The bushing bearings are superior in many respects to the usual plain babbitted bearings. When ball-bearings are used, the belts, of course, run in oil and the bearings are dust-proof.

The base of the machine is of a box-shaped section and the top of the base onto which the individual drill frames are bolted is also made of a box section, which maintains the truth of the surface onto which the frames are bolted, a feature which is highly important if accuracy is expected. The table of the machine is heavily ribbed on the under side in a manner very similar to that of a surface plate; this is indicated both in Figs. 1 and 2. This method of ribbing is very necessary on a machine of this type, where accurate work is to be performed. Often the tables of sensitive drill presses are not strong enough to carry the heavy weight of the work with its drill jig, when placed on one corner of the table, without springing to some extent, and in such cases it is, of course, impossible to drill a hole that is at right angles to the base surface of the work. The table is raised and lowered by an elevating screw which is stationary and engages with a revolving nut hand-wheel, the thrust being taken by a ball-bearing. It is not necessary to cut a hole in the floor in order to get the extreme range of the vertical movement of the table. A groove is provided around the edge of the table for oil or other drilling compound.

It will be seen in Fig. 1 that a foot-treadle is provided on both sides of the machine, so that the shipper may be operated by the foot from either side, according to the position of the operator. A locking arrangement consisting of a latch which holds the shipper positively in position when once operated, is provided. This locking arrangement, however, does not prevent the shipper from returning to its original position when the foot-treadle is again pressed, but it locks it in the position to which it has been brought by the last operation of the shipper treadle.

The sliding head is held at any desired position on the face of the column by a binder on the side of the head. An interesting feature in the design of the head is the ratchet feed employed. The feed is by a lever, as usual, which is of sufficient diameter and length to allow of heavy feeds for large drills. By means of a slight twist of the handle, the ratchet pawl is brought out of engagement with any one groove in the ratchet collar, and brought into engagement with the next groove, the engagement being positive as long as there is no twisting action on the handle. This design is very simple, but handy and efficient. The lever can be moved quickly from a short to a long leverage, and can be locked, if required, in any position, but the tension on the spring employed in the ratchet feed device provides enough pressure to ordinarily hold it in any position. The lever is knurled on the end sufficiently to get a good grip.

On the side of the spindle a positive stop arrangement is provided. This device is made in two styles. The regular style consists of a screw provided with two nuts, one of which acts as a check nut binding the other on the screw on which they are both mounted. The nuts abut against a projection of the head when the spindle is brought down. This stop is positive and can be adjusted for very fine differences in measurements when required. It is set, of course, by means of a scale or standard measuring blocks. The special type of stop consists of a micrometer stop arrangement which makes it possible to take actual measurements directly, without the use of a scale. The screw on which the stop nuts are mounted has, in this case, been milled away nearly to its center, and on the flat surface thus provided a scale is graduated, on one side of the center line in tenths, and on the other side in fourths, of an inch. A graduated micrometer collar is then provided on the screw, by means of which it is possible to take any measurements varying by thousandths of an inch. The micrometer screw is adjustable in its end bearings, so that it can be brought up or down as required, in order that readings for different depths of drilled holes may be made to start at zero. The thread of the micrometer screw is a ratchet thread being made like a square thread on one side, and with an angle on the other. As the square side of the thread takes the thrust, this makes a very strong, positive and durable stop.

The machine is furnished with from one to four spindles, as required, and it will drive to their full capacity, high-speed drills up to 29/32 inch in diameter, these drill sizes regularly having a No. 2 Morse taper shank, the spindle being provided with a No. 2 Morse taper socket.

The general dimensions of the machine are as follows: The distance from the face of the column to the center of the spindles is 7 inches and the distance between the spindles 9 inches. The maximum distance from the lower spindle end to the table is 24 inches, and it is possible to bring the spindle clear down to the table. The vertical adjustment of the spindle head is 11 inches, and that of the table 12 inches; the vertical feed of the spindle is 5 inches. The diameter of the spindle pulley is 4 inches. The working surface of the table for the 4-spindle machine is 11 x 41 inches, the outside of the table being 14 x 44 inches. The tables of the one-, two- and three-spindle machines are, of course, proportionally smaller. The diameter of the main driving pulley is 8 inches and its face 2½ inches for the four-spindle machine. The floor space required for the same machine is 33 x 48 inches and the weight is 1,230 pounds.

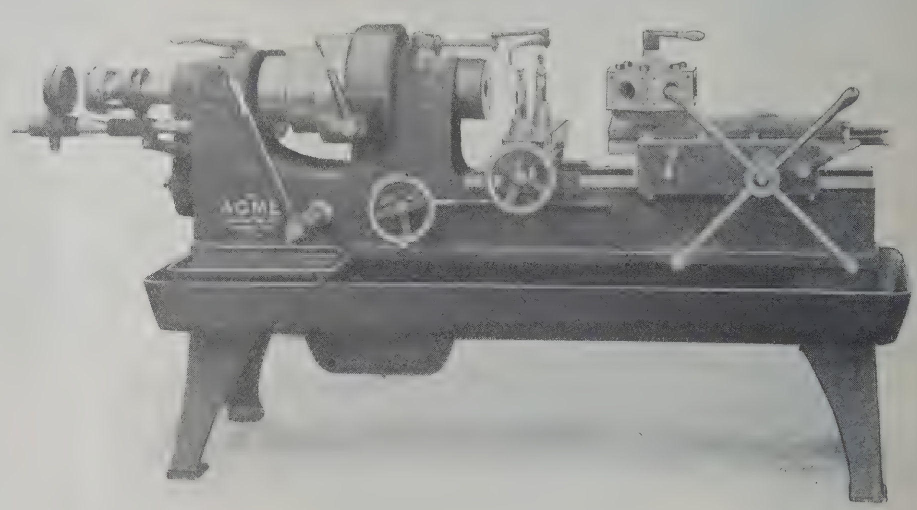


Fig. 1. The Acme Turret Lathe

THE ACME TURRET LATHE

The turret lathe or screw machine herewith illustrated and described is the product of a new firm, the Acme Machine Tool Co., of Cincinnati, O. The machine gives evidence on the first inspection of having been designed to meet the demand for a high grade, powerful tool, for use with high-speed steel. This is evidenced, for instance, by the fact that the head-stock is cast solid with the bed, and by the provision of a wide-faced, three-step cone with a friction clutch back-gear drive. The clutches are so arranged that the spindle can be stopped by throwing the operating lever to the middle position. The deep chip pan should also be noted. This will hold a liberal quantity of chips and oil, making it unnecessary to be constantly cleaning it out when taking rapid reduction cuts on steel.

The spindle runs in ring oiling babbitted bearings of ample size. The end thrust is taken at the front bearing, thus avoiding danger of binding or loosening from the unequal expansion of the steel spindle and the cast iron bed. The automatic chuck is forged solid on the end of the spindle, reducing the overhang, and supporting the collet firmly at its extreme outer end. A master collet is furnished with each machine, together with one set of bushings for stock of the largest capacity of the spindle. The chuck and stock-

feeding lever is placed within easy reach of the operator. Special attention has, in fact, been given to the location of all the hand wheels, levers, etc., to permit easy manipulation without requiring the operator to shift his position.

Interesting details of the turret slide mechanism are shown in Figs. 3 and 4. The turret *A* is hexagonal in form and is provided with tapped holes for attaching tools to the face, in addition to the regular holes with the binder bushings. A hole of the same diameter as those in the turret is bored through the turret stem *B*, thus allowing long work to be turned with short stiff tools. The tool clearance over the top of the slide is made extra large to permit the use of large dies and turret tools, while the slide itself is made wide to give rigidity to the turret and tools. This will be seen in Fig. 4.

Taper gibs *C* and *C*, also shown in Fig. 4, adjust the slide horizontally, while the slide bed has interposed between it and the top of the bed, the taper shim *D*, which by means of screws *E*, *E*, can be adjusted forward or back so as to raise or lower the turret. These two adjustments, working in combination, serve to preserve the alignment of the turret holes with the spindle. An interesting point in the construc-

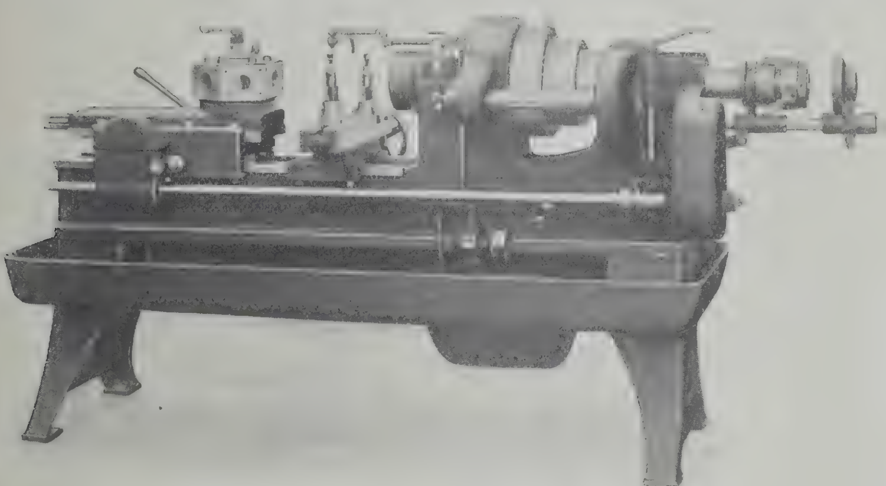


Fig. 2. Rear View of Machine, showing Feed Mechanism

tion of the taper shim *D* will be noticed in Fig. 3. The points of screws *E* bear on inclined surfaces, so that when

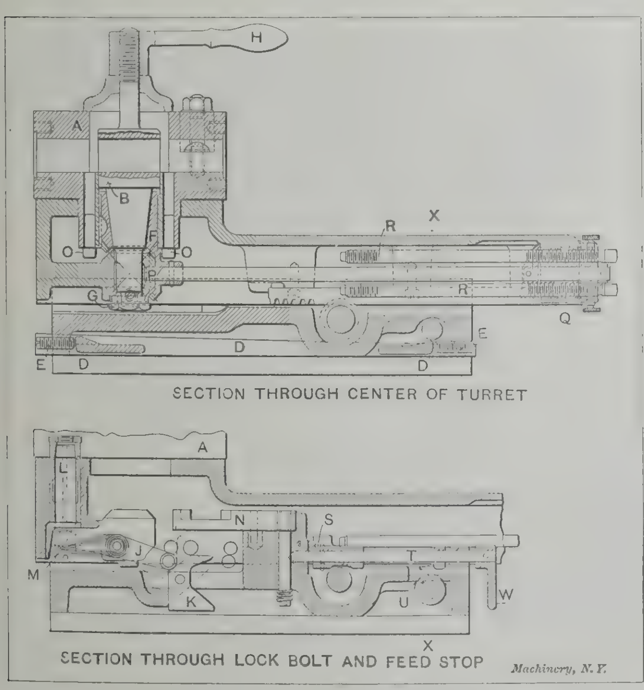


Fig. 3. Longitudinal Sections, showing Turret Indexing and Feed Mechanisms

the turret slide bed is raised from the bed of the machine, shim *D* goes with it, being held without danger of dropping loose.

The neck of the turret contains a bronze sleeve *F*, which is keyed to it, and thus revolves with it. This is bored taper to form a seat for the binding bolt *B*. By adjusting nut *G*, the turret may be held to its seat with any desired degree

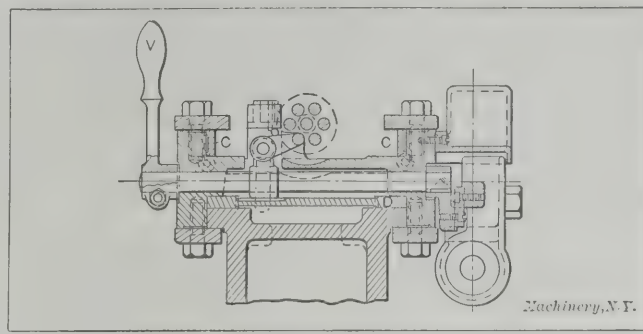


Fig. 4. The Feed and Automatic Stop Motions

of freedom, irrespective of the action of the regular clamp handle.

The turret revolving mechanism is shown most plainly in the lower view of Fig. 3. As the turret slide nears the limit of its backward movement, the roll on the end of lock bolt lever *J* runs up the incline of tumbler *K*, thus withdrawing the turret lock bolt *L* against the pressure of spring *M*. When *L* has been withdrawn, pawl *N* engages one of six hardened pins *O* driven into the neck of the turret (see upper view) and thus revolves the latter. At the conclusion of the indexing at the extreme end of the stroke, the roller at the end of *J* runs off the back side of tumbler *K*, locking the turret in position again. As the slide comes forward for its next cut, the tumbler *K* tips down out of the way of *J*, and pawl *N* snaps in back of the next pin *O*, both being thus in position to index again on the next return movement.

Details of the turret feed mechanism are shown in both Figs. 3 and 4. An independent stop is provided for each face of the turret. Bushing *F*, already mentioned, has bevel gear teeth cut on it meshing with a corresponding bevel gear *P*, which, by means of the shaft to which it is pinned, revolves the stop cylinder *Q*. This latter carries a series of six stop screws *R*, which are thus brought successively into position in line with the stop screw abutment *S*. The striking of the stop screw against this abutment first throws out the automatic feed (if it is engaged), and then brings up against a positive stop immediately afterwards. This permits using the automatic feed in turning up to a shoulder, which may then be finished by hand, allowing the cut to run out until the face has been smoothed up. The abutment *S* is pinned to a rod *T*, carrying a collar engaging the trip *U*, by means of which the power feed is thrown out. Lever *V* is used for throwing the feed out or in by hand. Also pinned to *T* is the handle *W*, which permits abutment *S* to be swung around out of the way of the stop screws, so as to feed beyond the positive stop, should occasion so require.

The power feed is driven positively from the spindle by gearing enclosed in the case shown at the right of Fig. 2. This gearing provides four changes of feed, controlled by a handle extending over the rear head-stock bearing. This power feed may be attached to the machine after it is purchased, if desired by the user, without additional machining.

The cross-slide is provided with a large graduated dial and positive stops. It has a hand longitudinal adjustment by means of the hand-wheel, bevel gears and screw shown on the front of the bed. This screw runs in a bronze nut screwed to the flat gib of the cross-slide, and is protected from chips and dirt by means of steel tubing. Power feed will be supplied for this cut-off if desired.

A double taper friction countershaft of improved design is

supplied. The construction of the clutch is shown in Fig. 5. The shaft A_1 has keyed to it the driving sleeve B_1. Interlocking with projections on this sleeve, but free to slide on the shaft, is a friction clutch C_1. Bearing sleeve D_1 is a sliding fit in the hub of pulley E_1 and revolves on driving sleeve B_1. It is provided with a large oil chamber holding enough lubricant to run a month or more without refilling. When thimble J_1 is pressed toward the left, levers K_1, of which one only is shown, operate to engage the friction surfaces of E_1 and C_1 in a perfectly obvious manner. Ample adjustment for wear is provided by loosening screw H_1 and turning nut F_1 to bring

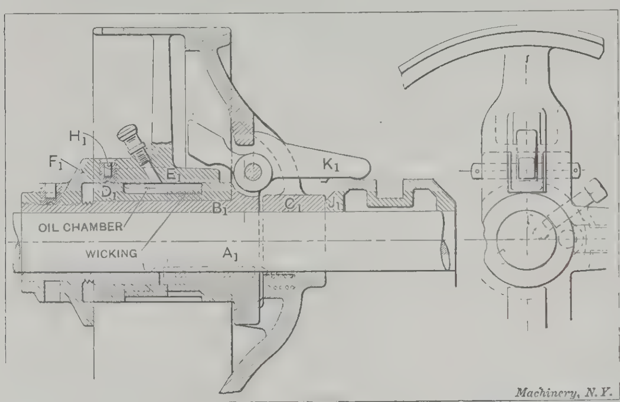


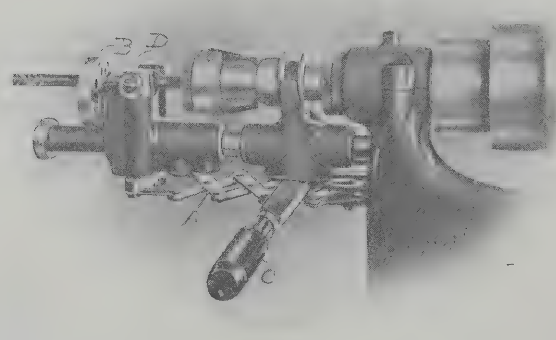
Fig. 5. Detail of Countershaft Clutch Construction

the pulley into closer engagement with the cone surface of C_1. This construction will be appreciated by mechanics who have had to dismantle the counter-shaft and face of the hub of the pulley, in order to get more adjustment.

The machine illustrated is provided with chuck and stock feed, and power feed for the turret slide. It may be purchased without these attachments, however, either of which may be added at a later time without requiring any further machine work on the lathe. The same is true of a power feed to the cut-off slide, which will also be provided for work which requires it.

WELLS IMPROVED WIRE FEED

The accompanying illustration shows an improvement which has been introduced on the hand screw machine made by the F. E. Wells & Son Co., Greenfield, Mass. The advantage of this wire feed is that a single lever movement takes care of all operations and movements of the various parts necessary, including the opening of the chuck, the feeding of the stock forward, and the closing of the chuck. It is not necessary

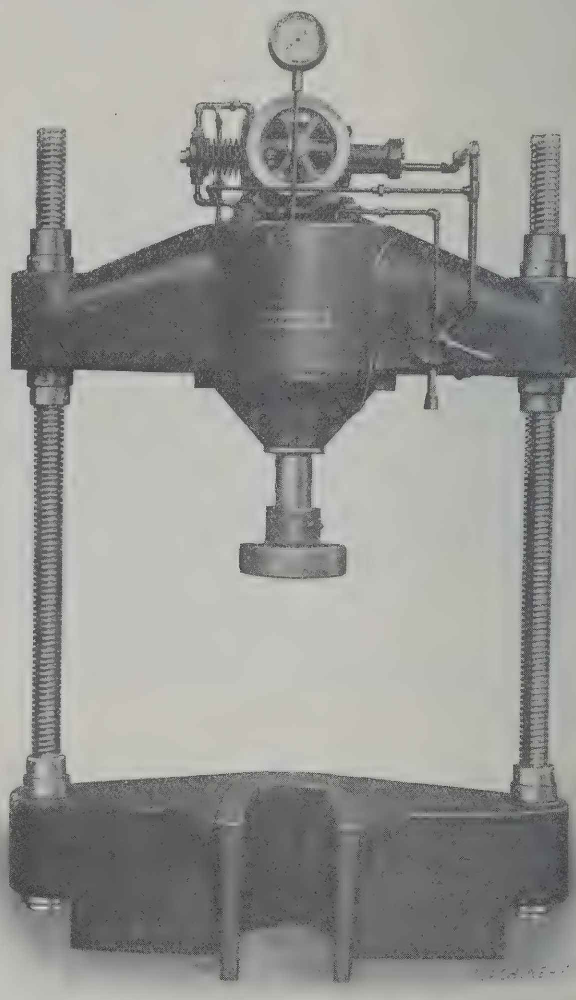


Improved Wire Feed Mechanism, made by the F. E. Wells & Son Co., Greenfield, Mass.

to fasten a dog, collar, or other device to the stock, as is the case with the ordinary type of wire feed. The operation of the device is briefly as follows: When the lever C is pulled forward, the two fingers D, which are provided with cam surfaces on their inner faces, are given a slight turn so that they grip the stock between them. By means of the pantograph, or "Jacob's ladder" arrangement shown at A, the bracket holding the fingers D is made to move through a distance very much greater than that of the movement of the lever C, so that a considerable length of stock may be fed in by a comparatively short movement of the feed lever. When the lever C is moved back after the stock has been pulled forward, the fingers are again opened and are ready to take a new hold on the stock as soon as the handle C is again operated forward. At the same time that the fingers are released and moved back, the bracket immediately above the handle C, which is provided with a yoke engaging with the chuck closing collar, is moved backward, and the chuck is closed, so that thus all the operations of feeding the stock forward and the opening and closing of the chuck are accomplished by a slight movement of a single lever, without any additional manipulation. The disk shown at B is a guide for the stock and can be adjusted for different diameters.

SPRINGFIELD PNEUMATIC PRESS

The illustration shows an ingenious press for shop use made by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O. It is intended for general shop use in the insertion and removal of heavy arbors, and in making the press fits met



Pneumatic Press with Automatic Intensifier

with in machine building. It is an improved design of the machine shown in the department of New Machinery and Tools of the August, 1908, number of MACHINERY.

This machine operates by air pressure, either direct or intensified, as will be described. It consists primarily of two heavy frame castings, upper and lower, held together by the strong screws shown on each side. The construction of the lower base permits a large wheel up to 38½ inches in diameter to be placed between the screws. The opening permits the work to be pushed into place instead of being lifted off as would often be necessary if a circular opening only were provided. The two upright screws support the upper frame on the nuts shown. These are adjustable so that the upper frame can be lowered or raised to agree with the height of work being operated upon.

As stated, the press is operated pneumatically. The piston is 15 inches in diameter with a stroke of 8 inches. With an initial pressure of 80 pounds this gives a pressure on the work of 7 tons when direct air pressure is being used. For work

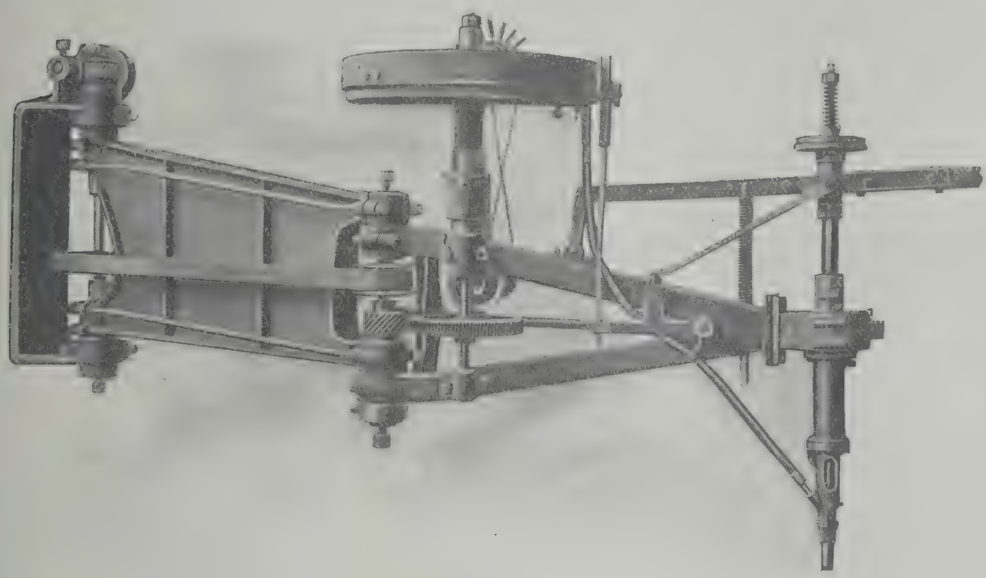
requiring a greater effort, the automatic pump mechanism, shown mounted on the top of the upper frame, is used. This is, in effect, a compressed air engine driving an air compressor capable of giving a maximum pressure of 225 pounds against the 15-inch piston, giving a pressure on the work of about 20 tons.

All the movements of the press are controlled by the valve shown at the right-hand side of the upper frame. In one position of this handle, the piston is raised, and in the next position the initial air pressure is admitted above the cylinder. Should this not be sufficient to drive the work together, the handle is moved to the third position, which automatically starts the pump, gradually increasing the pressure to the desired point. A gage is furnished so that the operator may know at all times what pressure is being applied to the work.

The distance between the upright screws is 38½ inches. The maximum distance of the plunger at its topmost position to the bottom of the base is 42 inches. The machine requires a floor space of 24 by 48 inches.

REYNOLDS RADIAL SCREW DRIVING MACHINE

In the January, 1909, issue of MACHINERY an automatic screw driving machine built by the Reynolds Machinery Co., Moline, Ill., was illustrated and described. The accompanying illustration shows another machine built by this company, which is the latest addition to the line of screw driving machines manufactured by the firm. This machine covers a range of work for which the regular stationary type shown with the previous description is not available, and bears the same relation to the regular or upright type as a radial drilling machine does to an upright drill press. The illustration shows the machine, which consists merely of an arm which can be mounted in any convenient manner, for example, on a post or on the wall of the building in which the machine is used. The working parts of the machine are mounted on the arm which is provided with a joint at about one-half of the distance of the spindle from the wall. The arm is of such proportions that the screw-driving spindle can be brought to a maximum distance of 7 feet from the post, and owing to the jointed construction, the arm may be swung around so that the spindle can be placed in any position within the circumference of a 14-foot diameter circle, except for a small area close to the post.



Radial Automatic Screw Driving Machine, built by Reynolds Machinery Co., Moline, Ill.

The spindle of the machine is spring counterbalanced so that it is automatically raised as soon as the operating lever is released. In operation, the screws are simply thrown into the pan or hopper shown at the top in the illustration. The work is then placed in such a position that the spindle end can reach the place where it is desired to drive the screw. The operator holds the feed lever in in one hand and places the other on the head of the machine so as to be able to swing it quickly into the desired position. He then depresses the lever as soon as the spindle comes in the desired position, thereby starting the screw. The spindle runs at about 800 revolutions per minute, so that the screws are driven in place practically instantly. The size of the machine shown in the half-tone is capable of driving screws up to No. 20, 4 inches long. The magazine, the friction-driven spindle, chuck, hopper, etc., are of the same design as that successfully used in the stationary type of machine previously described.

The machine is built to deliver, if necessary, 3 horse-power to the spindle, thus providing ample power for the largest screw within its capacity. It may be driven either from the line-shaft, counter-shaft, or by individual motor.

NEWTON CYLINDER BORING MACHINE

A new design of cylinder boring machine, which has been adopted as a standard by its builder, the Newton Machine Tool Works, Inc., Philadelphia, Pa., is shown in the accompanying engravings. This machine, as is evident after an examination of the illustrations, is exceptionally massive. The spindle is 8 inches in diameter and its bearings, both in the driving head and outer support, are amply large to insure rigidity and a minimum of wear. The particular machine

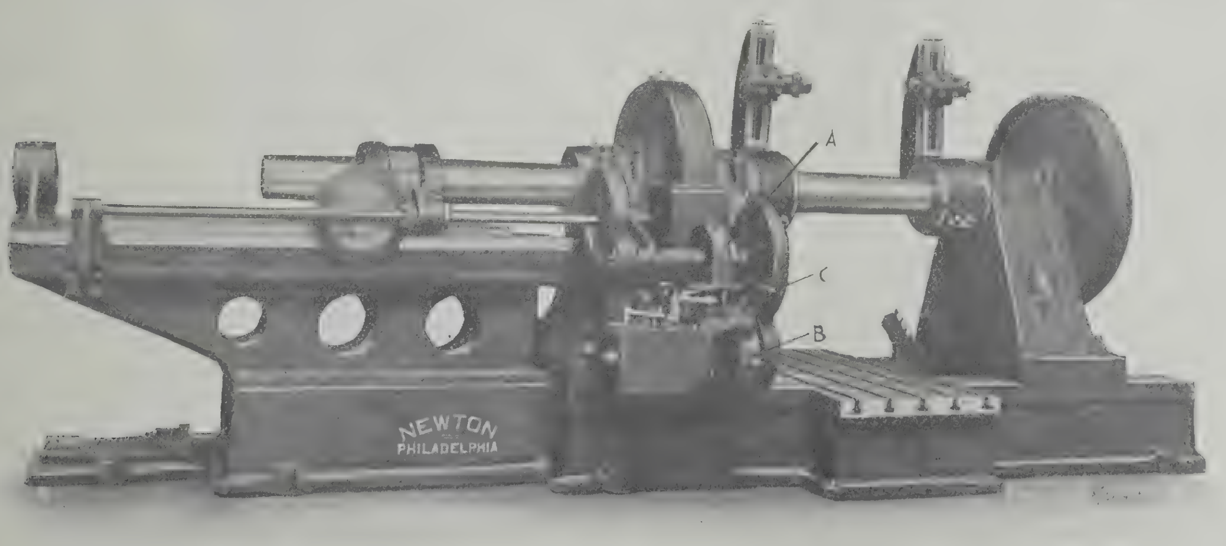


Fig. 1. Front View of the Latest Design of Newton Cylinder Boring Machine

illustrated is intended to be driven by a variable speed motor which will be belted to the single driving pulley shown at the rear of the machine in Fig. 2. From the shaft on which this pulley is mounted, the motion is transmitted by spur gears to a driving worm meshing with a large worm-wheel which is mounted on a sleeve that revolves in bearings at each end of the head. This sleeve, which is 33 inches in length, transmits the motion to the boring-bar. The driving worm is of hardened steel, while the worm-wheel is of cast iron with an outer ring of bronze. The worm is provided with roll thrust bearings, and it has a triple thread of 6-inch lead. The bearing

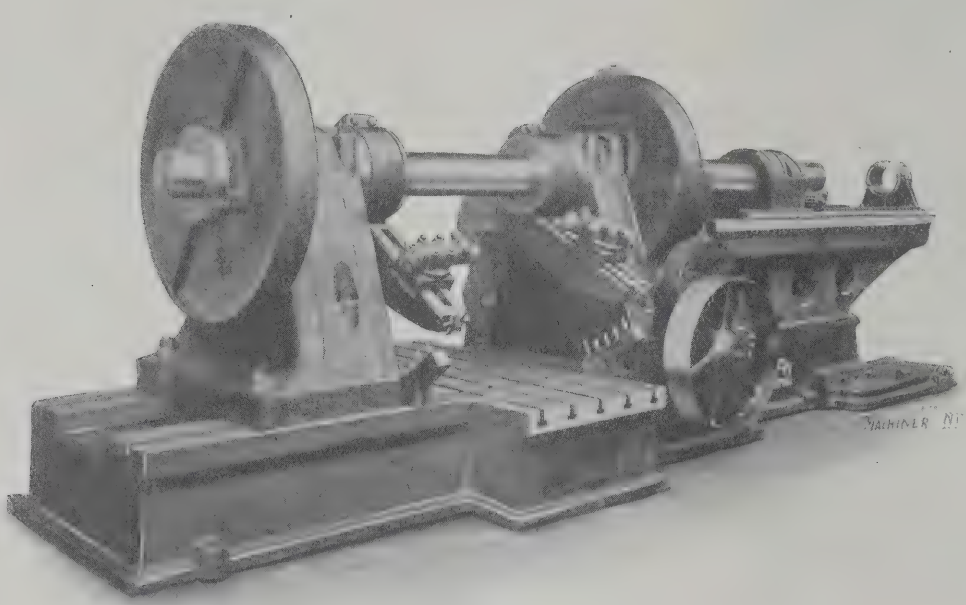
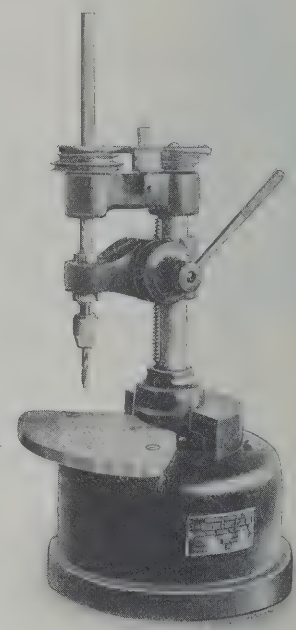


Fig. 2. Rear View of the Newton Cylinder Boring Machine

sleeve in the outboard head for supporting the end of the bar, is of large diameter and has a length of about 20 inches. The feed motion for the bar is transmitted from the end of the driving shaft to the worm-wheel *B*, which is mounted on the feed box shaft. From this shaft, through the different combinations of gears, nine changes of feed are obtained. A feed yoke which may be gripped to the bar at any point, and which is driven by pinions on either side of it meshing with racks mounted upon a supporting bed, serves to transmit the motion to the bar. This bed, as will be seen, is unusually rigid. For the fast traverse of the bar the worm shaft is connected with an idler male friction gear at *A*. The hand-lever *C* operates a friction clutch, controlling the fast traverse of the spindle and also the tooth clutch that engages the feed. With this design of drive and feed it is possible to obtain great variations in the spindle speed, although the present machine is arranged for from 3 to 9 revolutions per minute of the spindle, and for feeds ranging from 0.062 inch to 0.647 inch per revolution of the spindle. The length of the feed is 72 inches, and the distance from the center of the spindle to the top of the work table is 37½ inches. The facing arms are mounted on extensions of the spindle sleeves, permitting adjustments of the spindle without interfering with the arms. If desired, these arms can remain stationary while the spindle rotates. They are furnished with swiveling tool-holders which are mounted on a slide having a reversing power feed. This machine is furnished, when desired, with a counterbalance, as shown, to equalize the weight of the facing arms and to insure a steady even motion of the spindle when boring and facing at the same time. The machine has a capacity for boring cylinders up to 40 inches in diameter, and it will bore and face cylinders up to 50 inches in length. When motor-driven, the machine requires a 15-horse-power motor which should have, preferably, a 3 to 1 speed variation.

HOLTZER-CABOT UNIVERSAL DRILL

The accompanying illustration shows a small drill made by the Holtzer-Cabot Electric Co., 621 Albany St., Boston, Mass. This machine is intended for use in garages, machine and repair shops, and in manufacturing plants where light metal work is handled, as well as in all other places where there is a considerable amount of light drill press work. The arrangement of the drill is rather ingenious and novel. As shown in the illustration, the drill is mounted directly on the motor casing, the main driving shaft passing up through the inside of the column, and transmitting the power by means of a round belt on a three-step grooved pulley, a small idler being provided to furnish the required contact of the belt with the pulley, this being necessary on account of the short center distance between the two grooved pulleys. The



A Small Drill Press of Novel Design

chuck will take drills up to 13/64 inch diameter. The tool is equipped with a ¼ horse-power motor and is arranged to drill at speeds varying from 800 to 2,700 revolutions per minute. Motors are supplied for any class of electric current supply.

* * *

NEW MACHINERY AND TOOLS NOTES

Combined Punch and Shear: Covington Machine Co., Covington, Va. This is a punch and shear of the type in which the two machines are set back to back, with a common driving mechanism. The novelty of the design lies in the provision of sliding gears for giving a choice of either of two different speeds, depending on the service demanded.

Handy Die Stock: Handy Mfg. Co., Bridgeport, Conn. This die-stock is intended to cut a wide range of sizes with one set of dies, and without requiring the use of special tools for adjustment. It is at the present made in four sizes—the smaller size with single and the larger with double end chasers, to give different pitches for different diameters of pipe.

Speed Indicator with Timing Attachment: Karl Weiss, 30 Woodlawn Terrace, Waterbury, Conn. This is a combination of watch movement and speed indicator, which automatically throws the worm gear out of mesh with the worm at the expiration of any desired time, up to three minutes. Its use makes the watch unnecessary when timing shafts and other rotating parts.

Hand Press: Standard Machinery Co., Providence, R. I. This machine is of the vertical slide type, with a cast iron frame mounted on a table with legs. The slide is cast in one piece and has attached to it a machine steel rack, operated by a pinion mounted on the lever shaft. It is adapted to fine work requiring more sensitive action than is obtainable with a hand-wheel or foot-treadle.

Centrifugal Hot Air Polishing and Drying Machine: Tolhurst Machine Works, Troy, N. Y. This machine is intended for cleaning small metal articles after electro-plating. It has been found that when such work is rotated at high speed in a centrifugal drier and subjected to a blast of hot air for 10 minutes or so, a high polish results. While the action is somewhat obscure, it is said to give unusually good results.

Draftsmen's Square and Protractor: D. J. Kelsey, New Haven, Conn. This protractor is similar in design to the maker's celluloid protractor, but is made of sheet steel. The edges of the tool are turned down to secure stiffness and to

prevent the contact of broad bearing surfaces of metal with the paper, and the consequent rubbing of dirt into the drawing. The swinging arm is graduated in 32nds of an inch. A vernier reading to 10 minutes is provided.

Double Spindle Polishing and Buffing Lathe: Osborn Mfg. Co., Cleveland, O. This tool comprises two separate buffing and polishing spindles, mounted in a single frame, of light but very rigid construction. The shape of the front legs is such as to permit two men to work easily on the same machine without interfering with each other. The spindle drives are separate, so that the stopping of one spindle does not interfere with the other, while the advantages of the double machine in the matter of space economy are retained.

Adjustable Drill Jig: G. R. Carlson, 367 Ellicott St., Buffalo, N. Y. This tool has a work-table 5 inches square, mounted on slides having screw adjustments in both horizontal directions, read by micrometer dials graduated to thousandths of an inch. A drill bushing is supported by a vertically-adjustable overhanging arm. The work-table is provided with slots for holding parallels or stops for locating the work. The device weighs about 15 pounds, and should be useful in work made in too small quantities to make a special jig profitable.

Twenty-inch Drill: Aurora Tool Works, Aurora, Ind. This machine is an improvement over previous designs, the principal improvement consisting in increasing the strength and weight of the machine. It is built either plain or with back gears. The maximum distance between the spindle and the table at the base is 31 inches, and between the spindle and the regular drill table, 20 inches. The table has a traverse of 20 inches and the spindle a traverse of 7 inches. The machine requires one horse-power for its drive. The floor space occupied is 36 by 18 inches.

Calibrating Apparatus for High Pressure Gages: Watson-Stillman Co., 192 Fulton St., New York City. This apparatus is designed for calibrating master gages or for comparing other gages with a master gage. In the first case the pressure is applied directly by weights acting on a piston in a carefully designed and fitted cylinder. Provision is made for eliminating friction effects and for controlling the pressure within fine limits, permitting accurate work in testing. In the second case the two gages are connected with a cylinder in which the pressure is produced by a hand-operated screw action.

Turbine Dynamometer: Herschell-Spillman Co., N. Tonawanda, N. Y. This is an absorption dynamometer in which the resistance is furnished by a turbine pump construction, discharging in a closed circuit through a by-pass. The by-pass may be throttled more or less to change the load imposed by the action of the blades on the water. The introduction of a small supply of fresh water serves to regulate the temperature and keep it below the boiling point. It is particularly adapted to automobile engine testing and will be furnished with a frame to fit the same testing stand in which the engines are mounted.

Adjustable Bolt and Clamping Device: Red Wing Adjustable Bolt Co., Red Wing, Minn. This adjustable bolt is intended for various temporary uses, but particularly for securing work to the tables of machine tools. It can be quickly shifted to vary the length, and is therefore of advantage in cases where it would otherwise be necessary to have a large assortment of different lengths of bolts for clamping. The bolts are provided with ratchet-shaped stops, on any one of which a clamp may be secured. Two bolts comprise a set, and by means of these and a U-clamp, work of a great variety may be clamped down.

Bi-centric Master-keyed Padlock: Yale & Towne Mfg. Co., 9 Murray St., New York City. This is a new design of padlock of the highest quality, embodying the makers "Bi-centric" system of master-keying. Separate plugs are provided for the master key and the operating key. When thus made, the locks may be arranged in any number of sets, each set controlled by a master key and all controlled by a grand master key. No two padlocks have keys alike, and the original simplicity and security of the pin-tumbler mechanism is not impaired. The locks can also be arranged as for safe deposit system, so that the use of two keys is required to operate the lock.

Ronson Universal Wrench: Cryder & Co., Park Ave. and 63rd St., New York City. This wrench, when closed is only 6 inches in length and weighs but 8 ounces, though it provides 9 wrenches in one, ranging in size from 3/16 to 13/16 inch. It consists in general of a set of four wrenches, held together by a screw and wing nut in the center. The wrenches are slotted so that any one of the four wrenches may be projected outside of the others, when it is to be used. When one of the wrenches is pulled out for use, the others form a handle, giving considerable leverage. The screw passing through the slot in the wrenches has a square body, making it impossible for the members to turn.

Stop Mechanism for Lathe Cross-slide and Carriage Movements; Lodge & Shipley Machine Tool Co., Cincinnati, O. In the July and August, 1909, numbers of Machinery, department of New Machinery and Tools, we described two special forms of Lodge & Shipley lathes, in which an improved stop mechanism was incorporated as one of the principal features. The builders are now prepared to furnish their regular patent head lathes in the smaller sizes with this stop mechanism, giving such lathes many of the advantages of the turret machine in the matter of the duplication of diameters and shoulder lengths. With the use of these stops, a single tool may be used for turning or boring duplicate work of considerable complication.

Automatic Tapping Chuck: Pawtucket Tool Co., Inc., Pawtucket, R. I. Two styles of automatic tapping chucks, known as styles A and B Thompson chucks, have been brought out by this company. The style A chuck is intended for use in radial drills and the style B more especially for upright drills; the latter style contains its own reversing mechanism, while the other is employed on machines on which such mechanism is already incorporated. There are no projecting parts on these chucks. The advantages claimed for them are that they are simple in construction and require no tightening and loosening. Holes can be tapped clear to the bottom, and the breakage of taps is practically eliminated. The chuck stops automatically and instantaneously at the bottom of the hole.

Riveting Machine: Charles Greiner Co., New Haven, Conn. The principal feature of this machine is its high speed; the machine will strike from 1,000 to 6,000 blows per minute when the treadle is depressed. The principal working element of the machine is a spring cushion hammer which works in a gun metal cylinder and which is actuated by the engagement of a roll at its upper end, with cam-like projections on the end of a flange which revolves on a horizontal plane and is driven by a friction clutch. In combination with the great number of blows per minute the hammer spins at a high rate of speed and causes the head of the rivet to be evenly spread. The elastic blow prevents injury to fine work and allows working of rivets at different heights without altering the adjustment.

Horizontal, Boring, Drilling and Milling Machine: Fosdick Machine Tool Co., Cincinnati, O. This machine, known as the style A, is a new design capable of performing all the operations of drilling, milling, tapping, boring, facing, etc., on light and heavy work, within the dimensional limits of the machine. It is of the type in which the spindle is mounted on a head, vertically adjustable on the face of a column, which is itself horizontally adjustable on the base of the machine. A particular feature of the design is the rugged construction of the slide mechanism for operating the boring bar feed. Special attention has also been given to placing the spindle-driving gears close to the work, so as to reduce to a minimum the torsional stress in the spindle. Power feed and quick-return movements are applied to the movement of the column on the base, and to the movement of the head on the column. Eight changes of positive feed are provided for these movements, as well as for the end motion of the spindle. There are sixteen spindle speeds, ranging from 4 to 216 revolutions per minute. The machine is built in two sizes. The No. 1 machine has a table 42 by 72 inches area, and the No. 2, 42 by 120 inches. An outboard support for the boring bar is provided, adjustable horizontally and vertically. The machine will also be furnished, if desired, with a constant or variable speed motor drive. All the gears are of steel and the bearings are all bronze bushed. Careful attention has been given to workmanship and design in all details throughout the machine.

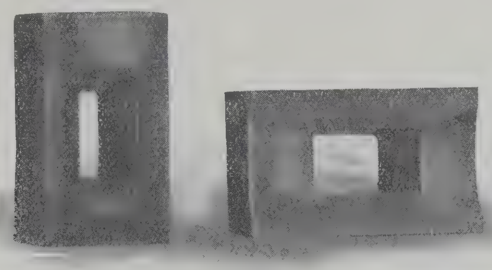
* * *

VANADIUM FORGING DIES

The severity of the service imposed on riveters and forging dies, boiler punches and other tools in similar uses often makes the upkeep abnormally expensive even when the best carbon steel is used. It is in such trying situations that certain alloy steels have shown marked superiority—a superiority so great in fact as to be in some instances very noteworthy. For example, in a ship-building yard on certain severe work, pneumatic hammer riveting dies made of the best carbon steel obtainable and treated in approved manner lasted only about ten hours each. The vibrations crystallized the shanks of the dies, the result being breakage at the juncture of the shank and the die proper. When these carbon steel riveter dies were replaced by vanadium steel dies, their life was greatly extended, fourteen months' service being reported by one concern using this alloy for its pneumatic riveter dies. An article on the characteristics of vanadium steel referring to its marked superiority for severe service was published in the engineering edition of Machinery, October, 1907.

The accompanying illustration shows a pair of forging dies made of mild type H vanadium steel supplied by the American Vanadium Co., Frick Building, Pittsburg, Pa., which are worthy of attention in this connection. In this case the bes

carbon steel dies lasted only about two days when worked to the limit of capacity. The vanadium steel dies substituted have been in service for four months, and are still in good shape. The ratio of gain in endurance is already 60 to 1, and the prospect is that it will be much greater. Type H vanadium steel analyzes: carbon, 0.75; chromium, 0.90; vanadium (contained), 0.25; sulphur and phosphorus, very low. The amount of vanadium contained is small, being only about 1/400 of the total. It is evident, as has been before remarked, that vanadium has a very subtle and marked physic effect to make so great a change in characteristics of steel when administered in such small quantities. It seems to make a great improvement by its presence alone aside from its chemical combina-



Vanadium Forging Dies

tion. Vanadium acts as a deoxidizer, and counteracts the effect of fatigue and induced crystallization, the prime cause of failure of riveter dies, forging dies, and other dies and punches subjected to severe and often repeated shocks.

It is interesting to note that recent practice in making vanadium alloys tends toward the use of even smaller quantities of vanadium, particularly in iron castings. Where the practice several years ago ran about 0.25 per cent it is now found advisable to reduce the vanadium content to 0.12 or 0.10 per cent. Sometimes even smaller percentages are used with marked increase of tensile strength and elasticity.

* * *

In the account of MACHINERY's seventh annual outing in the November number it was stated that the Sandy Hook R. R. is the only railroad owned by the United States Government. This statement is an error. The Panama R. R. is also owned by the government; it was purchased with the Panama Canal.

* * *

PERSONALS

R. H. Victory, formerly of the Lowell Machine Shops, Lowell, Mass., is now assistant superintendent with the Eastern Bolt & Nut Co., Providence, R. I.

David Millington is now traveling in Europe introducing a new line of full and one-half automatic screw machines lately brought out by Ludwig Loewe & Co., Berlin, Germany.

Charles Flannigan has been made superintendent of the Fox Machine Co., Grand Rapids, Mich., succeeding Matthew Lund, who has been placed on the road as salesman for the company.

John W. Doyle, for fifty-two years an employe of the George W. Prentiss Wire Co., Holyoke, Mass., and for many years foreman of the fine wire department, has resigned on account of ill health.

Guy H. Gibbs, who has been with the Westinghouse Electric & Mfg. Co. for the past eight years, four of which have been with that company's Cincinnati office, is now with the Western Electric Co. at Cincinnati.

T. Commerford Martin, for many years editor of the *Electrical World*, has retired to become permanent secretary of the National Electric Light Association. Mr. Martin is writing the biography of Thomas A. Edison.

C. A. Koehler, for the past three years foreman of the wood pattern department of the Chapman Valve Mfg. Co., Springfield, Mass., has resigned to become foreman of the wood pattern work of the Stevens-Duryea Co., Chicopee Falls, Mass.

Henry L. Barton, for several years works manager of the Westinghouse Machine Co., East Pittsburg, Pa., has left that company, and with others has formed a new company known as the Metal Products Co. which will manufacture automobile parts in Detroit, Mich.

Charles E. Meech, secretary of Wilmarth & Morman Co., Grand Rapids, Mich., who has been in charge of the company's Alaska-Yukon-Pacific exposition in Seattle, Wash., is now making an extended business trip in the interests of the company along the Pacific coast.

Holden I. Crane, for the past six years connected with the operating department of the Cincinnati Milling Machine Co., Cincinnati, Ohio, and Percy S. Crane, a well-known Cincinnati business man, have formed the Crane Machine Tool Co., and have taken over the sensitive drill business of the Knecht Bros. Co.

Francis Walker has been employed sixty-four years without a break in the Fairbanks Co.'s scale factory, St. Johnsbury, Vt., and for forty-nine years has been at the head of its foundry department. Col. Walker, as he is known in his home town, was eighty-four years old October 27, and, despite his age, he is at his post every day directing the work of 160 men.

A. P. Warner, vice-president of the Warner Instrument Co., Beloit, Wis., whose purchase of a Herring-Curtiss aeroplane was mentioned in the August number, has made a few successful trials on the Morgan farm near Beloit. The first flight was made November 2, when a height of about fifty feet was attained. Mr. Warner has an improved form of aeroplane in mind, and if his plans are successful it is possible that he will manufacture aeroplanes for sale.

* * *

OBITUARIES

Frank J. Ludington, an inventor of cigarette-making machinery, died at Waterbury October 2, aged sixty-three years.

Richard Watson Gilder, editor of the *Century* and a well-known author and poet, died suddenly of heart disease in New York, November 18, aged sixty-five.

George W. Hoffman, manufacturer of the U. S. metal polish, and other specialties, died at his home in Indianapolis, Ind., October 22, after a short illness. The business will be continued by his widow.

Joseph B. Bancroft, president of the Draper Co., Oakdale, Mass., manufacturers of cotton mill machinery, died at his home in Oakdale, October 25, aged eighty-eight. He succeeded Gen. William F. Draper as head of the Draper Co., two years ago.

Tatem Parsons, the first engineer of the locomotive *John Bull*, died at Camden, N. J., November 5, aged ninety years. He was the first engineer to handle the throttle. The famous locomotive is now in the National Museum at Washington, D. C.

Lemuel Coburn, president of the Coburn Trolley Track Co., Holyoke, Mass., died at his home in Holyoke, October 26, aged seventy-nine years. Mr. Coburn was the inventor of the Coburn trolley apparatus and of many other devices, among which was a successful rag cutter for paper mills. This rag-cutting machine first brought Mr. Coburn prominently before the mechanical world.

John Moffitt, inventor of the threshing machine, died recently in Denver, aged eighty-four years. Moffitt constructed his first threshing machine on his father's farm near Canton, Ohio, in 1851, to do away with the old flail method of threshing grain. It proved to be so great an advance that it brought him international fame. The new machine was exhibited at the world's fair in London in 1851 where it attracted the attention of royalty itself. Mr. Moffitt built and sold his thresher for several years and later became interested in the rubber business in Boston. Still later he went to California and engaged in mining, and developed a cheap and expeditious method of smelting; also improved mining machinery.

Edward D. Entwhistle, who in his youth was a fireman and engineer of George Stephenson's locomotive *Rocket*, died at his home in Des Moines, Iowa, November 1, in his ninety-fifth year. He was only sixteen when employed by Stephenson as fireman of the *Rocket* on its epoch-making trial trip from Manchester to Liverpool in 1831. After a few trips Stephenson turned the care of the locomotive over to Entwhistle, who made two trips daily over the first railroad for nearly three years. Mr. Entwhistle came to the United States, and in 1856 settled in Des Moines. He was first employed in the United States as engineer on the steamer *Troy* running on the Hudson River, and later was engineer of one of the lake steamers for several years. In Des Moines he was in charge of the engines of various large mills. He had a clear memory of his trial trip with Stephenson, and the enthusiasm of the crowds who witnessed it. He lived in Des Moines for fifty-three years.

Robert M. Van Arsdale, publisher of the *American Engineer and Railroad Journal*, died suddenly of apoplexy at his home in New York, November 23, aged sixty-one years. Mr. Van Arsdale was connected with trade journalism from his twenty-fifth year when he became associated with a high tariff paper in Chicago. In 1875 he joined the staff of the *Railroad Gazette* as advertising solicitor, and remained with that journal until he purchased the *National Car Builder* and began its publication in 1880, with James Gillet editor. In 1896 Mr. Van Arsdale purchased the *American Engineer and Railroad Journal* from M. N. Forney, who remained its editor for one year, when the two papers were combined under the name of *American Engineer, Car Builder and Railroad Journal.* Two

years later the name was changed to the present title, *American Engineer and Railroad Journal*, G. M. Basford then being the editor, who was succeeded by R. V. Wright, the present editor, in 1905. Mr. Van Arsdale had a wide acquaintance among railway mechanical officials and manufacturers of railway supplies, and was a man highly esteemed by his friends and acquaintances. He is survived by his widow. The burial was in Chicago.

* * *

COMING EVENTS

December 1-3.—Annual convention of the National Society for the Promotion of Industrial Education. An exhibition of school work from all over the United States will be one of the features. J. C. Monaghan, secretary, 20 West 44th St., New York.

December 6.—New York meeting of the American Society of Refrigerating Engineers. Secretary W. H. Ross, 154 Nassau St., N. Y.

December 7-10.—Thirtieth annual meeting of the American Society of Mechanical Engineers in the Engineering Societies Building, 29 West 39th St., New York. The professional papers assigned to the meeting are as follows: Tests on a Venturi Meter for Boiler Feed, Charles M. Allen; The Pitot Tube as a Steam Meter, George F. Gebhardt; Efficiency Tests of Steam Nozzles, F. H. Sibley and T. S. Kemble; An Electric Gas Meter, C. C. Thomas; Tan Bark as a Boiler Fuel, David M. Myers; Cooling Towers for Steam and Gas Power Plants, J. R. Bibbins; Some Studies in Rolling Mill Engines, W. P. Caine; An Experience with Leaky Vertical Fire Tube Boilers and the Best Form of Longitudinal Joint for Boilers, F. W. Dean; Testing Suction Gas Producers with a Koerting Ejector, C. M. Garland and A. P. Kratz; Bituminous Gas Producer, J. R. Bibbins; The Bucyrus Locomotive Pile Driver, Walter Ferris; Line Shaft Efficiency, Mechanical and Economic, Henry Hess; Pump Valves and Valve Areas and a Report on Cast Iron Test Bars, A. F. Nagle. The social entertainment will be in charge of the members residing in and around New York, under the direction of a local committee, of which Mr. William D. Hoxie is chairman. A number of excursions are planned to points of interest, and a lecture for members and guests on agricultural machinery will be given in the evening of one of the meeting days.

December 8-10.—Annual meeting of the American Society of Chemical Engineers, Philadelphia, Pa. J. C. Olsen, secretary, Polytechnic Institute, Brooklyn, N. Y.

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers' tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 18-20.—Annual meeting of the American Society of Heating and Ventilating Engineers. W. M. Mackay, secretary, P. O. Box 1818, New York.

January 19-20.—Annual meeting of American Society of Civil Engineers, New York. Charles W. Hunt, secretary, 220 West 57th St., New York.

June 1-August 31, 1910.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

SOCIETIES AND COLLEGES

Teachers' College, Columbia University, New York, has planned a series of night courses by which young men who have first-rate technical ability in the wood-working and machinist's trades can prepare themselves for the profession of teaching in industrial schools. This course is being offered at night in the school in industrial arts, and covers mathematics, drafting, design, wood-working, machine shop work, industrial history and methods of teaching industrial arts. A three years' course of night work will enable an expert mechanic, otherwise qualified, to gain a diploma as teacher of industrial arts.

Technical Publicity Association, New York, held its second fall meeting Thursday evening, November 11, at the National Arts Club, 14 Gramercy Park. The subject of the evening's discussion was the merits of special issues of technical and trade papers. The argument for the affirmative was opened by James H. McGraw, president of the McGraw Publishing Co. The question was debated pro and con with enthusiasm. The vote on the question was in the negative, it being the opinion of the majority that there is no valid reason for the publication of special numbers to celebrate birthday anniversaries, etc.

Technical Publicity Association, of New York, held its first monthly meeting for 1909-10 Thursday evening, October 14, at its headquarters, 14 Gramercy Park. Mr. Charles S. Redfield, advertising manager of the Yale & Towne Mfg. Co., was toastmaster. George H. French, head of the advertising and sales department, delivered an address on the principles of advertising, of much general interest to advertisers and publicity managers. Howard M. Post, advertising manager of the Western Electric Co., told of plans for a systematic study of the direct results of trade paper advertising. The burden of Mr. French's talk was the psychology and psychological aspect of advertising copy.

British Association of Engineers, 17 Victoria St., Westminster, S.W., has instituted an employment register for the use of engineers seeking employment, the principal features of which are: No fee of any kind will be charged, the cost of the management being defrayed by the association with a view to the ultimate benefit of the profession; qualified engineers of all grades may have their names recorded, though in making the selection, preference, naturally, will be given to members of the society; only a few names of probable suitable candidates will be submitted for each vacancy, so as to facilitate the employer's choice; and effort will be made to get personal knowledge of the candidates with full details of their qualifications, etc. A. S. C. Ackerman is the secretary.

NEW BOOKS AND PAMPHLETS

Fuel Tests with Illinois Coal. By L. P. Breckenridge and Paul Diserens. 55 pages, 6 x 9 inches. Published by the Illinois Engineering Experiment Station, Urbana, Ill.

Utilization of Fuel in Locomotive Practice. Bulletin No. 402. By W. F. M. Goss. 28 pages, 6 by 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

Incidental Problems in Gas Producer Tests. Bulletin No. 393. By R. H. Fernald, C. D. Smith, J. K. Clement and H. A. Grine. 29 pages, 6 by 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

Commercial Deductions from Comparison of Gasoline and Alcohol Tests on Internal Combustion Engines.—Bulletin No. 392. By Robert M. Strong. 38 pages, 6 x 9 inches. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

Bulletins of Revenues and Expenses of Steam Roads in the United States for April, May and June, 1909. Published by the Interstate Commerce Commission, Washington, D. C.

These bulletins give the mileage of various railway systems and tables of revenues and expenses of railroad systems operating more than 500 miles of lines.

The Slide Rule. By J. J. Clark. 62 pages, 4¾ x 6¾ inches. Published by the Technical Supply Co., Scranton, Pa. Price 60 cents.

This book on the Mannheim slide rule is a plain, simple, practical description of the instrument and its use. The principles of logarithms are explained and the methods of use of the rule in combined multiplication and division, locating the decimal point, principles of reciprocals, square and square roots, cubes and cube roots, and trigonometrical functions. The treatment of the slide rule is one that will be appreciated by many who have never been able to use it with facility or satisfaction. The description is prepared in the plain, understandable style characteristic of the work of Mr. Clark, who is manager of the textbook department of the International Text Book Co., and dean of the faculty of the International Correspondence Schools. The book is highly recommended to all in need of a practical treatise on the subject.

Handy Man's Workshop and Laboratory. By A. Russell Bond. 467 pages, 5½ x 8 inches, 370 illustrations. Published by Munn & Co., Inc., New York. Price, $2.

This book was compiled largely from contributions published in the *Scientific American*, and valuable suggestions received in response to the opening of the department devoted to the interests of the "handy man." It treats of fitting up a work shop, shop kinks, the soldering of metals, and the preparation of solders and soldering agents, the handy man in the factory, and the handy man's experimental laboratory, and the handy man's electrical laboratory, the handy man about the house, and model flying machines. It will be found of considerable interest and probable value by amateurs and other tinkers who have a penchant for making models, model apparatus and repairing machinery. The book is an appropriate present for boys of mechanical tendencies and inventive ability.

Cyrus Hall McCormick—His Life and Work. By Herbert N. Casson. 264 pages, 5¼ x 8 inches. Published by A. C. McClurg & Co., Chicago, Ill.

In this book Mr. Casson has given an account of the life and activities of McCormick, the inventor of the reaper, in the same interesting style characterizing his books, "The Romance of the Steel" and "The Romance of the Reaper." The effect of the invention of harvesting machinery on the world's industrial activity is tremendous and can scarcely be over-estimated. The reaper made the work of one man as effective in harvesting grain as that of ten laborers before its advent. The harvesting machine has greatly increased the available food supply and is one of the great contributing causes of the advancement made in civilization and material comforts during the past sixty years. The book will be read with profit by all interested in the characteristics of a man who had the genius of the inventor combined with the capability of a remarkable business man.

Mechanical World Electrical Pocket Book for 1910. 271 pages, 4 x 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 6 d. net.

This electric pocket book is a companion publication to the well-known Mechanical World Pocket Diary and Year Book. The Electrical Pocket Book is confined to data on electrical matters comprising electrical units, resistance, specific resistance, mechanical and electrical unit equivalents, magnetos, electric bells and bell currents, electric transmission of power, dynamos and motors, methods of distinguishing electrical energy, alternating current systems, alternating current generators, polyphase motors, machine driving by electric motors, horse-power required to drive machinery, starting switches, motor generators, rotary converters, transformers, care and management of dynamos and motors, balancers, boosters, accumulators, conductors, cables, house wiring, circuit breakers, testing circuits, electric measuring instruments, lamps and lighting, electric welding, etc.

Prevention of Industrial Accidents. By Frank E. Law and William Newell. 194 pages, 5¼ x 7¾ inches. Published by the Fidelity and Casualty Co., New York. Price, 25 cents.

The appalling frequency of industrial accidents has aroused general interest in ways and means of accident prevention. Aside from the humanitarian aspect of the matter, the financial loss alone is so great as to demand the attention of manufacturers, business men and all concerned in the prevention of accidents from a purely selfish motive. In 1908 $22,392,072 was paid in premiums for liability insurance, which is an indication of the responsibility carried by the manufacturers and the burden imposed on industry as a whole by industrial accidents. The pamphlet discusses care on the part of employers and employees; safety devices; steam boilers; electrical apparatus; elevators; the factory; wood-working machinery, etc. It is thoroughly practical and will be found of general value by manufacturers and by employees in charge of apparatus likely to cause injury or death by accident.

The Steam Engine. By Charles H. Benjamin. 316 pages, 6 x 9 inches. 198 illustrations and diagrams. Published by the Technical Press, Brattleboro, Vt. Price, $3.

This treatise was prepared with the intention of covering practically the whole list of subjects relating to the steam engine, and is designed primarily for a text-book rather than a work of reference for engineers, although it will serve admirably for the latter purpose. The author explains the elementary principles of engines so that they may be readily understood by students. It pays much attention to practical problems, and questions in economy in operation are referred to the results of recent experiments made under working conditions. The contents of the work by chapters are as follows: Definition of terms, elementary principles, the simple steam engine, thermodynamics of air, thermodynamics of steam, valve and link motion, indicators and indicator diagrams, compound engines, conveyors, fly-wheels, steam in the cylinder, condensers, and heaters, piping and flow of steam, steam engine performance, steam engine design, specifications and costs. It closes with standard tables of weights of water, ammonia table and hyperbolic logarithms. The typographical excellence of the book is notable, the text, illustrations and press work being unexcelled.

Industrial Training; Twenty-Sixth Annual Report of the Bureau of Labor Statistics. 394 pages, 5½ x 8¾ inches. Published by the State Department of Labor, Albany, N. Y.

The report reviews the general conditions as to advancement in the manufacturing industries of New York State; the supply of skilled workers; the training of workers in industrial establishments; apprenticeship systems; attitude of employers and organized labor toward general industrial or preparatory schools; and attitude of organized labor toward trade schools. The summary of investigations is that the need of skilled male labor in the industries of the state is most severe in the manufacture of blown glass, many of the machinery and metal trades, manufacture of boots and shoes, and in certain of the building trades. It was found that the apprenticeship system in such industries as machine and building trades can be made more effective by introducing definite provision for systematic instruction. The need and value of general industrial and preparatory trade schools for boys and girls between fourteen and sixteen years is strongly testified by the reports

of employers in all industries and is agreed to by the labor unions. Practical trade schools seem to be most in need in the machine and buildings trades. An extension of evening schools giving both practical and technical instruction in the trades is demanded by employers in a large proportion of the industries.

HAND BOOK FOR MECHANICS. By Franklin E. Smith. 328 pages, 5 x 7½ inches. Published by D. Van Nostrand Co., New York. Price $1.50 net.

This book is intended for the general instruction of mechanics, particularly those who are weak in arithmetic. It treats of notation, addition, subtraction, multiplication, division, weights and measures, reduction of fractions, addition of fractions, arithmetical signs, subtraction of fractions, multiplication of fractions, division of fractions, decimal fractions, reduction of decimal fractions, addition of decimals, subtraction of decimals, multiplication of decimals, division of decimals, proportion, compound proportion, interest, involution and evolution, cube root. Part II treats of arithmetical signs and characters, and explains the solving of formulas. Part III is on mensuration and gives rules for finding the circumference, diameter and area of circles, area of ellipses, triangles, rhomboids, trapeziums, volume of solids including the sphere, cylinder, pyramid, cone and frustum. Part IV treats of weights, specific gravity, dimensions, measurements and weights of vessels, calculation of contents of tanks, cisterns, etc. Parts V and VI treat of the elements of simple machines, including the lever, pulley, wheel and axle, inclined plane, wedge and screw, and strength of materials. The work is one that can be recommended for the instruction of apprentices, mechanics and others who have not had the advantages of a good common school education, and it will also be found useful by those who desire to renew their knowledge of the things learned in youth and partly forgotten through disuse.

MECHANICAL DRAWING FOR TRADE SCHOOLS. By Charles C. Leeds. 122 pages, 8 x 11 inches. Published by D. Van Nostrand Co., New York. Price, $2 net.

The author, who is assistant to the head of the school for apprentices and journeymen Carnegie Technical Schools, has presented a work on mechanical drawing that is a refreshing contrast to many of the books on the subject that have been published. It has been prepared with the idea of making students in mechanical drawing think and work without merely copying models. It is the outgrowth of his work in the Carnegie Technical Schools where the importance of developing the faculty of imagination and mental picturing an object was forcibly impressed on him. It is a faculty that many students lack, and the need for developing it became very apparent. The book in the beginning treats of the tools and elementary processes used in drawing, comprising pencils, pencil points, drawing board, T-square, triangles, drawing lines, laying off dimensions, use of compass and dividers, drawing circles and arcs tangent to lines, lettering, sketching, inking, etc. The plan of the work is that of displaying the drawing to be made on the right-hand page, giving the instructions for making the drawing on the left-hand page. A large number of practical examples are given, comprising the following: Flanged pin, machine bolt, clamp, sleeve, problems in projection, flanged pulley, 8-inch hand-wheel, lathe face-plate, positive clutch coupling, compression shaft coupling, safety flange coupling, geometrical problems, ellipses, spur gear, conic sections, intersections and developments, bevel gear, 12-inch speed lathe details, comprising the legs, bed, tool-rest, tail-stock and head-stock, examples of tabular data, bench grinding details comprising the frame, commutator bar, commutator ring, armature spider, generator frame, worm gearing, plate cam, periphery cam, conventional signs used in structural work, standard framing, beam connection, etc. The book is one that we can recommend to those who would learn mechanical drawing at home, and to the instructors in trade schools and other institutions requiring a good practical work on the subject.

ELEMENTS OF MACHINE DESIGN—PART I. By W. Cawthorne Unwin. 531 pages, 5½ by 8½ inches. 387 illustrations and diagrams. Published by Longmans, Green & Co., London and New York. Price $2.50.

This well-known textbook on machine design was first published in 1877, and it since has been revised three times. In the revision of 1890 the chapters relating to steam engine details were published separately as Part II. Part I deals with general principles, strength of materials, rivets, bolts and other fastenings; journals and shafting; couplings; pedestals; transmission of power by gearing, belting, ropes and chains. In the present revision the work has been almost entirely rewritten, and the page size has been changed from 4½ by 6¾ to 5½ by 8½ inches. In the foreword the author writes of the great task of originally writing the book, and of the still greater task of keeping it abreast of the times, as follows: "If originally the author had fully realized the multiplicity and complexity of the problems which arise in designing machinery, the present treatise would probably not have been written. If he had now for the first time the task of writing it, he would no doubt take the view that for an adequate scientific treatment of the subject a much larger treatise would be necessary. . . . There are now so many aids to the study of the application of scientific principles to all branches of engineering practice and so much of engineering experience has been made accessible, that the difficulty of dealing with the subject at the time this book was written will hardly be recognized now. . . . This treatise was intended to occupy a distinct field between works on applied science and empirical books of rules and collections of examples of machine details." The practical nature of Unwin's work has been generally recognized, and the machine designer using it will find that the present edition upholds the plan of the former editions and extends and improves it. One new chapter on keys and cotters has been added besides the general additions and changes in all other chapters. The index his been somewhat extended, but much room is yet left for improvement.

CATALOGUES AND CIRCULARS

GISHOLT MACHINE CO., Madison, Wis. Leaflet illustrating and listing standard boring and facing tools for Gisholt lathes.

WASHBURN & GRANGER, 120 Liberty St., New York. Catalogue B of Dean dumping, shaking, and stationary boiler grates.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Copy of revised navy specifications covering electric motors and controlling devices.

HYDRO MFG. CO., Pittsburg, Pa. Circular of "Hydro" recording and velocity gage for measuring the rate of flow of gases in pipe lines or ducts.

SCHUTTE & KOERTING CO., Philadelphia, Pa. Circulars of Koerting deep-well water jet pump and water jet eductors for mines, tunnels, etc.

E. C. ATKINS & CO., INC., Indianapolis, Ind. Circular illustrating and describing Atkins AAA car mover, being an improved form of pinch-bar.

COLLINS WIRELESS TELEPHONE CO., 54-56 Clinton St., Newark, N. J. Catalogue of wireless telephone sets for experimental, lecture, office and field purposes.

PEERLESS ELECTRIC CO., Warren, O. Booklet illustrating the use of Peerless motors on paper box machinery, blowers, pumps, envelope mailing machines, etc.

FOSDICK MACHINE TOOL CO., Cincinnati, Ohio. Circulars of Nos. 1 and 2 Fosdick horizontal boring, drilling and milling machines of the elevating head type.

WALTON CO., Hartford, Conn. Circular of Walton extractor of broken taps. This extractor is made in 16 sizes, suitable for taps ¼ to 1¼-inch diameter.

PIKE MFG. CO., Pike, N. H. Mailing card advertising Pike's "Little Four" sharpening set, reversible oil stone, "Koenig" razor hone and "Pykarvo" knife sharpeners.

EMERSON ELECTRIC & MFG. CO., St. Louis, Mo. Bulletin No. 3309 replacing bulletin No. 3307 of electric forge blowers, direct connected for direct and alternating currents.

CRESCENT LAMP CO., 516-518 West Monroe St., Chicago, Ill. Circular of incandescent lamp guards, including the "Loxon," which is a guard that prevents theft as well as breakage.

NORTH BROS. MFG. CO., American St. and Lehigh Ave., Philadelphia, Pa. Circular illustrating and describing the "Yankee" breast drill with right- and left-hand ratchet movement.

AMERICAN BLOWER CO., Detroit, Mich. Sectional catalogue No. 250 of A B C blowers for cupolas, forges, melting and heating furnaces, forced draft, pneumatic tube systems, etc.

S. E. HORTON MACHINE CO., Windsor Locks, Conn. Price list of four-jaw independent reversible jaw chucks, made in seven sizes, covering the usual ratings of 8-inch to 26-inch sizes inclusive.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. Treatise on Cochrane feed water heaters and the profitable utilization of exhaust steam in condensing and non-condensing steam power plants.

F. W. DEVOE & C. T. RAYNOLDS CO., New York and Chicago. Catalogue of artists' and drawing materials, comprising colors, India inks, pencils, rubbers, pantographs, drawing instruments, T-squares, protractors, etc.

CELFOR TOOL CO., Buchanan, Mich, and 207 Railway Exchange, Chicago, Ill. Catalogue No. 10 of Celfor tools, reamers and three-lip drills, Rich flat drills, Celfor-Rich and quick-change chucks, reamer sockets, and grinding machinery.

SCHUMACHER & BOYE, Cincinnati, Ohio. Mailing folder illustrating S. & B. instantaneous change gear engine lathes, built in 18-inch, 20-inch, 24-inch, 26-inch, 30-inch, 36-inch, and 48-inch sizes. Details of construction, including double-plate apron and head-stock, are also shown.

CAMERON ENGINEERING CO., 154-156 Berriman St., Brooklyn, N. Y. Circular on overhead tramways, trolleys, switches, cranes, and scales for overhead handling and weighing; a pulley block crane mounted on four truck wheels, made in five sizes, and having a capacity from ½ to 3 tons.

STROMBERG ELECTRIC MFG. CO., 108-128 North Jefferson St., Chicago, Ill. Descriptive circular of new wall type electric chronograph for registering the time of entrance and exit of employees, the time of starting and completion of jobs and other purposes where a time registering device is essential.

UNION STEAM PUMP CO., Battle Creek, Mich. Catalogue B of Union air compressors, comprising a complete line of various types and sizes in ordinary use for operating pneumatic tools, coal cutters, pumps, sand blast work, and for other purposes, in foundries, machine shops and manufacturing plants.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. Pamphlet describing Cochrane steam stacks and cut-out valve heater and receiver, and its application in connection with commercial systems of exhaust steam heating. The diagrams illustrating the installations of service are printed in colors.

CARBORUNDUM CO., Niagara Falls, N. Y. Vol. VII of the "Revised American Statesman Series" on Benjamin Franklin, by F. W. Haskell, president of the Carborundum Co. The biography treats of the activities of B. Franklin in a brief but startling way, and we have no doubt that all readers of MACHINERY fortunate enough to receive one of these unique booklets will be much edified by the story.

GEORGE WESTINGHOUSE, Pittsburg, Pa. Pamphlet describing the Melville-Macalpine speed reducing gear for marine turbines; the 6,000 horse-power hydraulic absorption dynamometer used for testing the reducing gear at the works of the Westinghouse Machine Co., East Pittsburg, Pa., and report of tests of the reducing gear; also report of efficiency of high-speed steam turbines.

CLEVELAND PUNCH & SHEAR WORKS CO., Cleveland, O. Catalogue and stock list No. 3 of machines and small tools for the fabrication of iron and steel, comprising standard punches, coupling nuts, button-head rivet snaps (chrome-nickel alloy steel), twist drills, chisels, backing out punches, shear blades, punching machines, shears, I-beam punch, angle shears, bending rolls, rotary planers, wall radial drills, etc.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Circular No. 1181 of portable direct current ammeters and voltmeters. The characteristics of these instruments are accuracy and durability, though they are neither bulky nor heavy. They are operated on the D'Arsonval principle with a permanent magnet and moving coil. The magnetic structure is so arranged that the moving element can easily be taken out for repairs.

MAX VIEWEGER, 50 Church St., New York. Prospectus of the American Exposition to be held in Berlin, June, July and August, 1910, with diagram of floor space in exposition buildings Nos. 1 and 2. The prospectus gives the name of the American and German committees, which include such distinguished citizens as J. Pierpont Morgan, David R. Francis, John Wanamaker, Dr. George F. Kunz, Emil L. Boas, Dr. Nicholas Murray Butler, William G. McAdoo, C. A. Moore, etc.

NATIONAL-ACME MFG. CO., Cleveland, O. Circular illustrating the Acme automatic screw machine and samples of its work, also some interesting statistics. The company has a product department wherein 10,000,000 pounds of iron, steel and brass stock are annually cut into 100,000,000 parts. 3,000,000 screws and parts are carried in the New York store, 77 White St., 3,000,000 parts in the Chicago store, 56 West Washington St., and 15,000,000 in the Cleveland factory.

ARMSTRONG BROS. TOOL CO., 113 North Francisco Ave., Chicago, Ill. Catalogue and price list of Armstrong tool-holders, for turning, reaming, boring, slotting, drilling, cutting-off metals; and other machine shop specialties comprising lathe tool sets and cabinets, grinding holders, Armstrong cutting-off and grinding machines, drill and reamer holders, lathe tool-post, lathe dog, bolt driver, quick-action drill vise, planer jack, universal ratchet drill, automatic drill drift, C-clamps, etc.

NATIONAL TUBE CO., Frick Building, Pittsburg, Pa. Catalogue H-1909 of material manufactured by the Kewanee Works of the company, embracing wrought pipe for steam, gas, water and air, cast and malleable iron and brass fittings, brass and iron body valves and cocks, drive well points and well supplies. The catalogue is attractively arranged and well printed; some of the illustrations are partly in color to distinguish brass from iron. It should be in the files of all concerns using pipes, valves, cocks, flanges, and other supplies mentioned.

BUCKEYE ENGINE CO., Salem, Ohio. Catalogue of Buckeye electric blue-printing machines with testimonials of many users. The catalogue is unique in that the upper and lower edges of each page imitate the characteristics of blue-prints, being in blue with white lines. The Buckeye Engine Co. was one of the first American concerns to use blue-prints and it has consistently promoted their use for many years.

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

January, 1910

LOCOMOTIVE REPAIR SHOP PRACTICE—3

THE C., C., C. & ST. L. RY. SHOPS AT BEECH GROVE, INDIANA

ETHAN VIALL*

ABOUT five miles out of Indianapolis at Beech Grove, Indiana, there is a group of splendid new buildings, which is the nucleus of what will be, in the not-distant future, an immense plant known as the Big Four Railroad Shops. At present only the locomotive work is done there, the rest of the work being done at the old shops in Brightwood; but as soon as the buildings contemplated are finished the entire system of shops will be located at Beech Grove. Nowhere in the West are railroad shops better housed than are the boiler, machine and forging departments at this place. The immense buildings are as light as day, and the great height of the roofs makes them seem like a part of the great outdoors.

Fig. 1. Corner of the School-room for the Instruction of Apprentices in the Big Four Shops

Fig. 2. Cabinets for Storing Miscellaneous Parts and Notebooks used in Connection with the School Work

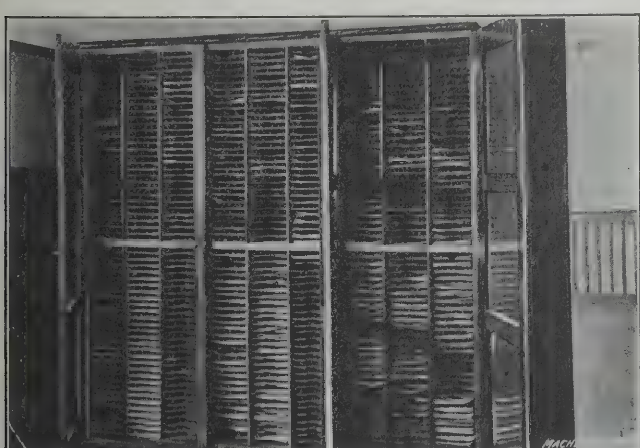


Fig. 3. Large Cabinet in which the Drawing and Instruction Papers are filed

Fig. 4. View of Wash-room for Machine Shop

The arrangement of the shop divisions and machinery is particularly good, which would naturally be expected in a new shop especially planned for a given purpose, but nevertheless a large amount of credit is due to Mr. J. McCarthy, superintendent of shops, whose ideas of what a railroad shop should be are certainly up to the best practice elsewhere. Mr. F. Bauer is the general foreman of these shops, and Mr. R. J. Williams the assistant general foreman, and it is to the last named gentleman that I am especially indebted for the time and trouble he took at a busy period in making the necessary arrangements and in giving me all the information required. I am also under obligation to Chief Clerk S. F. Taylor for many courtesies.

The Apprentice School System

In the big office building a large room is set apart for the apprentice school. This school is conducted on what is known as the New York Central apprentice school system, and at the present writing there are 49 boys taking the course, representing seven trades. These boys are divided into three classes, each class receiving instruction two mornings a week, from 7 to 9 o'clock. The days for instruction are Monday and Thursday, Tuesday and Friday, and Wednesday and Saturday for the respective classes. Before entering the school, a boy must pass an examination in simple arithmetic, reading and spelling, with an average of seventy per cent. If a boy passes, he is next sent to a doctor for a physical examination, and, if satisfactory, he is given a six months' trial to find out whether he will ever be of any use to a railroad or whether he is only cut out for a grocery clerk.

The apprentice course extends over a period of four years, and the boys are given instruction in mechanical drawing, algebra, geometry and trigonometry, so far as these apply to their future work, and the parts and mechanical working of the various railroad appliances. All tools and material used by a boy in the schoolroom are furnished free by the company, except a set of drawing instruments which are sold to him at actual cost. Besides the schoolroom work of four hours a week, the apprentices are constantly under the supervision of a shop instructor whose sole business it is to instruct them

* Associate Editor of MACHINERY.

in the running of the various machines on which they are working, how to use and handle tools, material and themselves. It is customary, when a boy shows ability, to give him from thirty to sixty days drawing. It was thought before starting the school that all of the boys would want to be draftsmen owing to its being cleaner than shop work, and that, in consequence, no shop men would be developed; in fact this was one of the strongest objections to the adoption of the apprentice school plan. In actual practice, however, the opposite has been the result, and draftsmen are almost as scarce as hens' teeth—only two having expressed a desire to be draftsmen since the school was established. Whether or not other similar schools show the same tendency, I do not know, but the result here is very gratifying to shop men.

The school instructor at Beech Grove is Mr. A. W. Martin, and the shop instructor Mr. John Buehler. These men are especially fitted for their work both by nature and education. The equipment of the schoolroom is unusually complete, and consists of drawing tables, charts, testing machines, locomotive, car, and air-brake parts and a well arranged blueprint room. A view of one corner of the schoolroom is given in Fig. 1, which shows how neat and well lighted it is and also a few of the charts and appliances. Fig. 2 shows two of the shelves, on which different parts are kept; the space under-

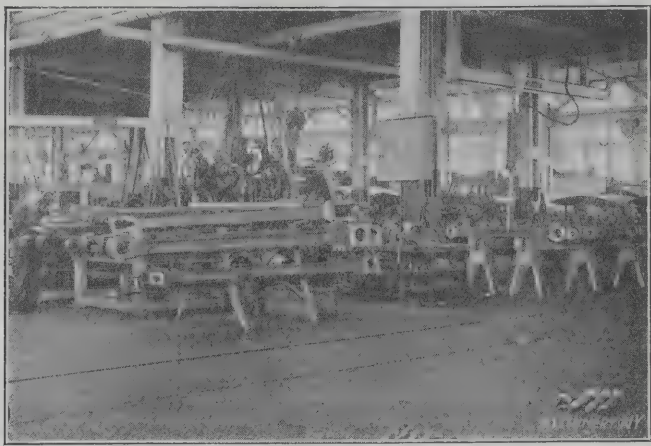


Fig. 5. General View in the Shop, showing its Neat and Orderly Appearance

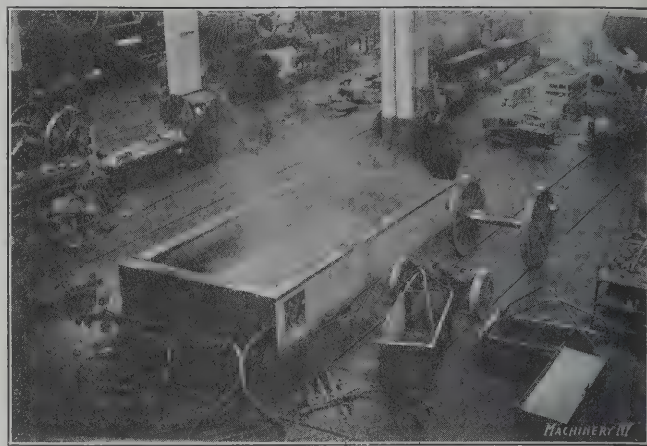


Fig. 6. Large Lye Tank in which the Grease is removed from the Dismantled Parts

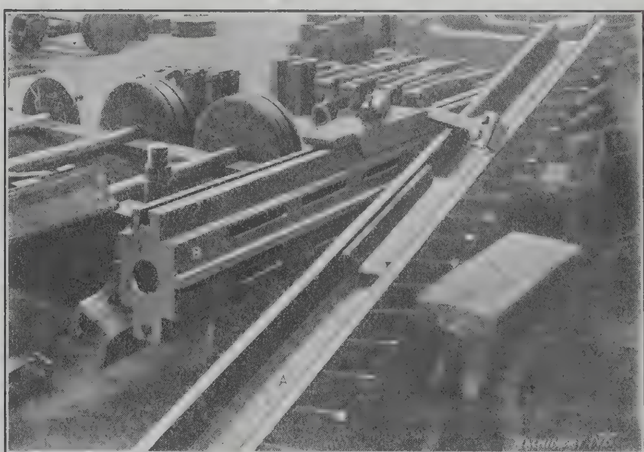


Fig. 7. The Fixtures used for Holding Shoes while planing the Inside and Flanges

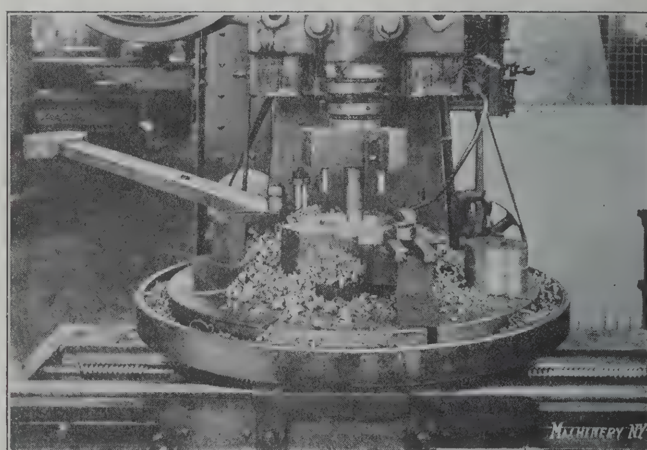


Fig. 8. Head with Three Cutters, used for blocking out the Ends of Solid Connecting-rods

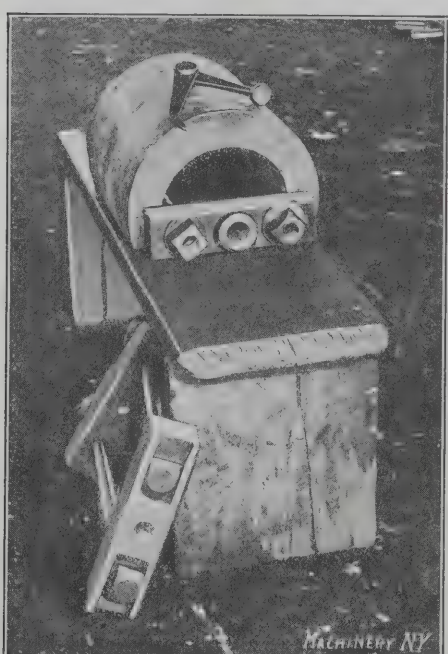


Fig. 9. Simple Form of Clamping Mandrel for Holding Driving-box Brasses while turning the Outside

Fig. 10. Fixture for Holding Brasses while the Edges are being planed, and Clutch for Handling them

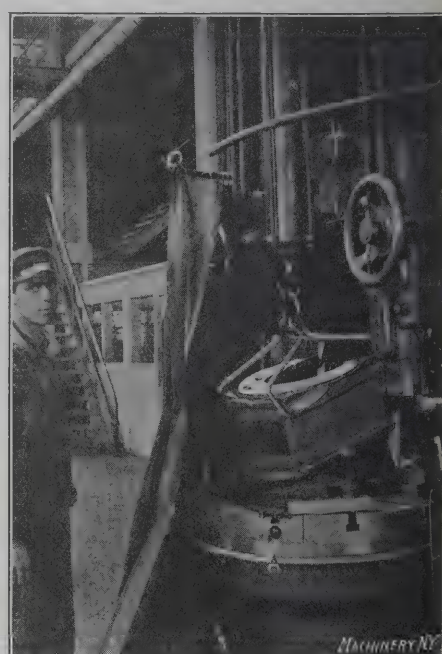


Fig. 11. Boring Mill Fitted with a Curtain to prevent Brass Chips from being scattered over the Floor

neath is used for storing the boys' note books, drawing instruments and the like. Drawing and other instruction papers are kept in the case shown in Fig. 3.

The Closets, Washrooms and General Orderliness

In the various shop departments the arrangements for the

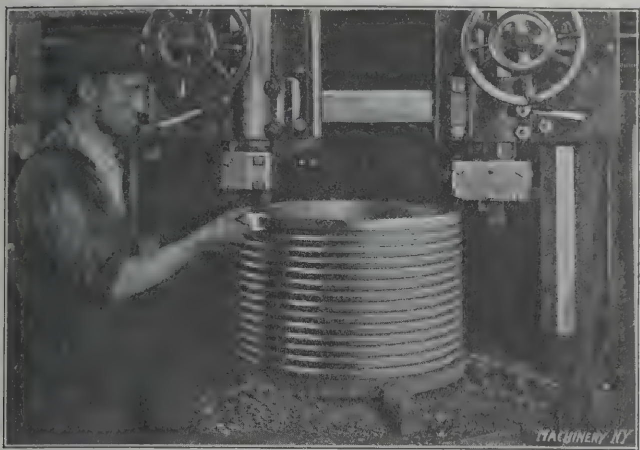


Fig. 12. Turning L-shaped Dunbar Packing Rings in the Vertical Boring Mill

comfort and sanitary welfare of the men are an agreeable surprise, as few shops of any kind in the country are so well equipped. Up on a platform or gallery running down the middle of the big machine shop is a series of closets, washrooms and shower baths arranged in units. One of the wash-

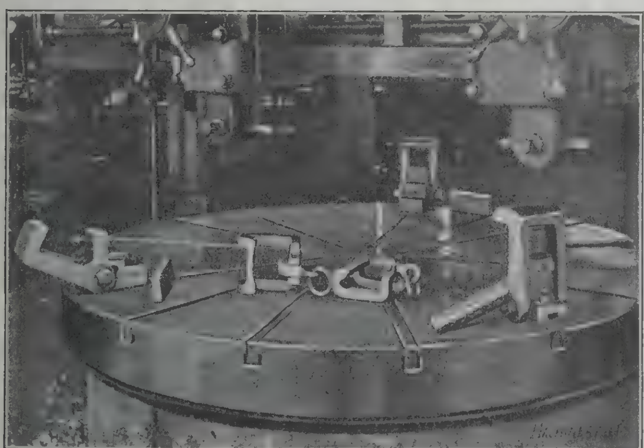


Fig. 14. Efficient Form of Clamp for Holding Wheel Tires while boring

rooms, with its concrete floor and individual porcelain wash bowls, with hot and cold water, is shown in Fig. 4. The bowls are all porcelain (and not merely coated iron), as these have been found cheaper in the long run, for enameled iron ones soon check up and rust, causing the enamel to flake off and soon destroying the entire bowl.

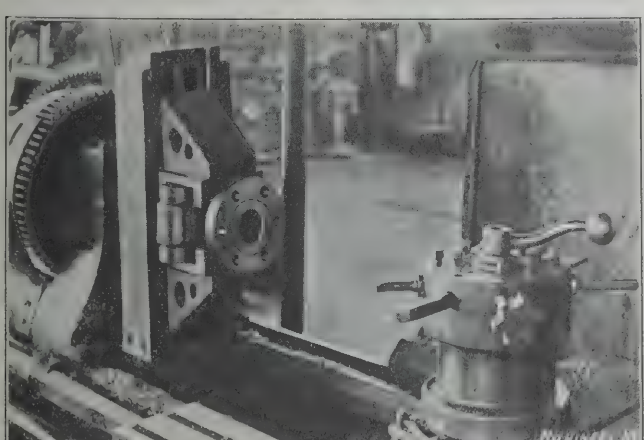


Fig. 16. Lathe equipped with Chuck and Turret, both of which were made in the Shop

In the main shop very few things are allowed to lie on the floor, cases and racks being provided for almost everything, as shown in Fig. 5, and when an engine is dismantled all loose parts are placed in a rack or case, so that in reassembling no overhauling of a mass of other old junk is necessary to find the parts of a certain locomotive.

This is one of the very few shops having the lye tank inside the building, as shown in Fig. 6; but the place is so large and the skylight ventilation so good that no fumes are noticeable anywhere. The tank is large enough to dip whole

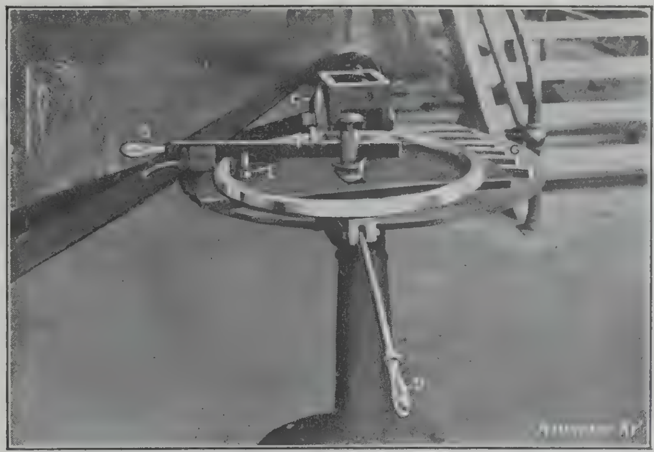


Fig. 13. Special Machine for Dividing and Cutting Packing Rings into Equal Segments

trucks in, or several big iron boxes full of parts may be immersed at once.

Planer Jigs for Shoes—Blocking Out Holes in Connecting-rods

The jigs, Fig. 7, used by Mr. C. L. Thomson, foreman of the

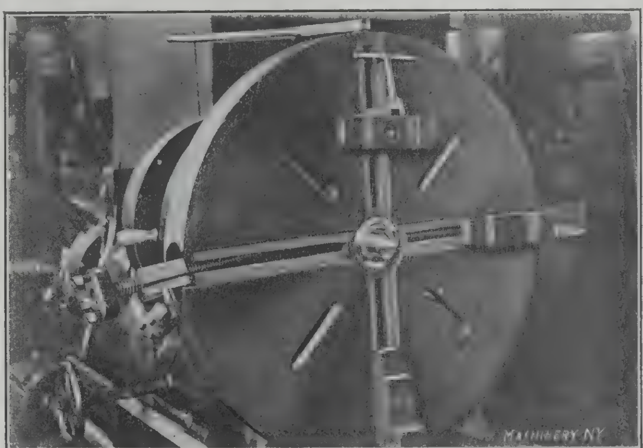


Fig. 15. Combined Faceplate and Chuck with Reversible Jaws which was made in the Shop

machine shop, for planing shoes in gangs, are worth describing. The shoes are first placed in jig *A* and the inside planed out; they are first roughed and then finished to size with the tool lying on top. Next they are placed on the "mandrel" *B* (a row on each side), which has a tongue that fits the middle slot in the planer table. One side of the series of shoes

Fig. 17. Self-Centering Clamping Mandrel for Holding Split Packing Rings while re-turning the Outside

is finished by using both planer heads. The mandrel is then turned over by means of the crane, the tongue on the opposite side fitting into the same table slot, and the other side of the shoes is finished. While this mandrel, at first sight,

seems unwieldly, it is not so in actual practice, as the crane handles it like a toy, and the large number of shoes finished at once makes this a very economical method.

Connecting-rod end holes are blocked out with a three-cutter cat-head, as shown in Fig. 8. The combined tools of this head cut a slot about 3/8 of an inch wide, and they are so ground that one cuts out a narrow slot at the left, the next one a narrow slot at the right, while the third takes out the middle, making a very smooth-running, fast-cutting device.

Driving Brass Turning Device

Driving brasses are held in a lathe while turning the outside in the special clamping mandrel shown in Fig. 9. The engraving shows the simplicity of this mandrel, and also the way the bolt heads are set in to prevent turning. The brasses are centered approximately before the final tightening of the clamping nuts by means of the ball-end caliper lying on top of the brass, the ball being placed in the center hole. The

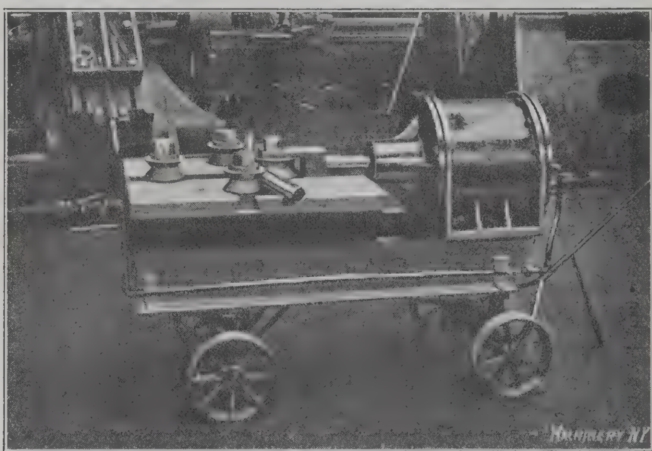


Fig. 18. Pneumatic Pipe Bender

edges of these brasses are planed off in a shaper while they are held in the jig shown in Fig. 10. The clutch used on the air hoist to grip them while handling is shown at *A*. The boxes are machined for the brasses on a slotter with a rotary table feed in the usual way, and after the brasses are pressed in they are bored out on the boring mill shown in Fig. 11, which is fitted with a curtain that effectually prevents the brass turnings from being thrown all over the floor while cutting at high speed. As the engraving shows, the upper curtain support has a gap in it for the air hoist. This support is made of pipe, and a short piece of rod stuck in the pipe is used to bridge across the gap and keep the curtain from dropping down while being pulled around to enclose the

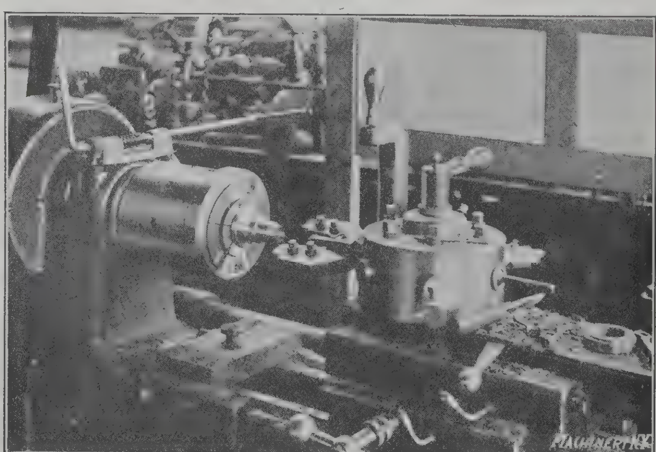


Fig. 19. Injector Nozzle being turned while held in Pneumatic Chuck

table. A guard rail *A* prevents the curtain from coming in contact with the revolving table. The simple form of clutch used to hold the box while lifting it with the air hoist is also plainly shown.

Making and Dividing Dunbar Packing Rings

The cast cylinders from which the L-rings for Dunbar packing are made are first turned on the outside, bored small and slotted in as shown in Fig. 12, the slots being slightly wider than the combined thickness of a slip ring and the cut-off tool used. A previously turned slip ring is then pressed onto the top L and the outside and top of the combination ring are finished. The outside edges are also rounded and the inside bored to size far enough down to meet a slot, previously cut nearly through by a cut-off tool from the outside, when the completed ring comes off, leaving another L-ring ready for

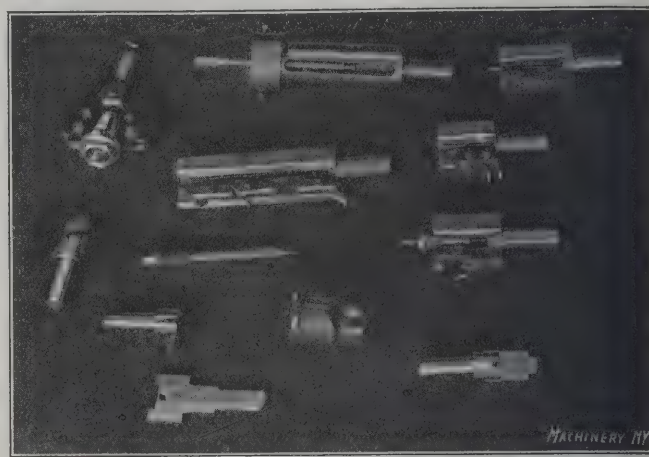


Fig. 20. Miscellaneous Tools used in the Brass Department

the fitting of the slip ring as at first. To save the trouble of laying off these rings when dividing them into segments, a special machine (Fig. 13) has been made. In using this machine the complete ring is placed as shown, the center pin of the clamping and spacing lever *B* fitting into a socket so that the entire lever and pin may be lifted off and then set down over the ring. The ring is then fed onto the milling saw *C* by pulling up on lever *D*, and as soon as the ring is cut through the lever is pushed down and the ring indexed by shoving lever *B* over against stop-pin *F*. The clamp on lever *B* is then released and it is brought back against pin *E*, clamped to the ring, and the ring again fed onto the saw.

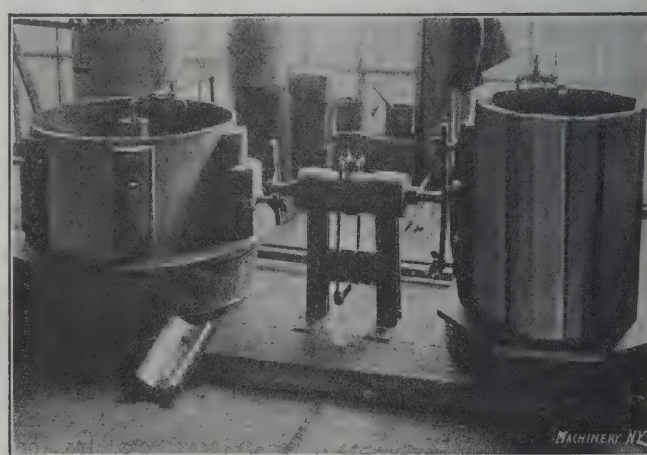


Fig. 21. Unique Device for the Babbitting of Brasses

This operation is repeated as often as is necessary to cut the required number of segments. The lever *B* and stop-pin *E* are adjustable for various sized rings or segments. The parts of a divided packing ring are shown at *G*.

Boring Mill Tire Clamps, Useful Lathe Chuck, Packing Ring Mandrel, etc.

In Fig. 14 are shown the tire clamps used to hold tires on the boring mill while boring them out. These clamps are considerably different from those used in either the Northwestern or Milwaukee shops, which were shown in the May and August numbers, respectively. The hooks are hinged so as to drop back out of the way while the tire is being put into place and centered by the set-screws shown. When the clamps are pushed up into an upright position a wide, thin wedge with a double bevel is driven in between the hook and the top of the tire to clamp it. The clutches used to grip the tire while using the air hoist are shown lying on the platen. These clutches, like the one shown at *A*, Fig. 10, are so made as to be self-locking, and the heavier the pull the tighter they grip.

An interesting chuck and face-plate made in the shop is shown in Fig. 15. The ease with which the jaws may be reversed, and the way they are guided by shallow grooves in

the faceplate, as well as the way the screws are set in are plainly indicated in the engraving. Another home-made chuck is shown in Fig. 16, and the turret shown is also a shop-made one.

Fig. 17 shows a self-centering clamping mandrel for holding one-piece split packing rings while re-turning the outside. This device is very similar to the kind used in automobile shops for the same purpose, an outer sleeve being used to compress and center the ring until it is clamped between the mandrel flanges, when the sleeve is removed.

A portable pneumatic pipe bender is shown in Fig. 18. As the engraving shows, the three rollers may be set in varying relative positions by moving them along the T-slots in the table in either direction. I have seen a number of portable pneumatic pipe benders, but this is the neatest and most compact yet.

In the Brass Department

Considerable brass work is done in the machine shop, and the turret machines for the most part are fitted with pneumatic chucks. Fig. 19 shows one of these with a brass injector nozzle in place and also the form of box finishing tool used, while Fig. 20 shows a number of box tools, flat drills and drill holders used. The long box tool at the top is a die holder with a special inside guide bushing for cutting the threads on a brass injector throttle stem.

Two old air cylinders have been rigged up into a press (Fig. 22) for the purpose of pressing cellar grease into cakes like the one on top of the barrel to the left. The upper cylin-

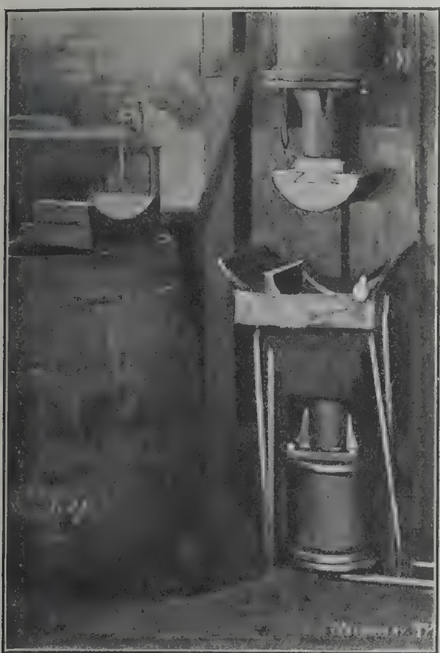


Fig. 22. Pneumatic Press for Forming Grease Cakes

Fig. 23. Two Telescoping Drill Sockets

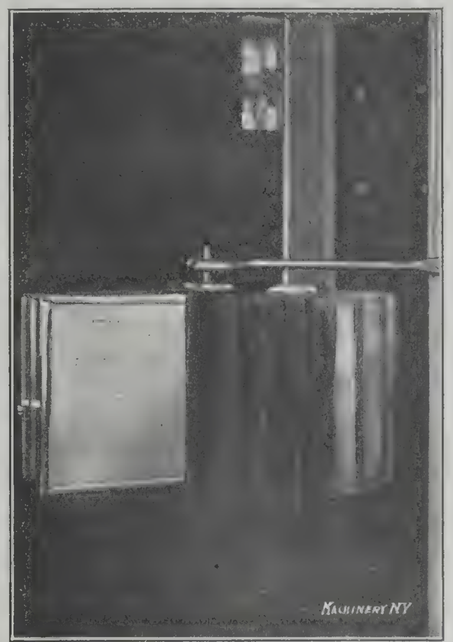


Fig. 24. One of the Books found in the Shops containing Piece-work Rates

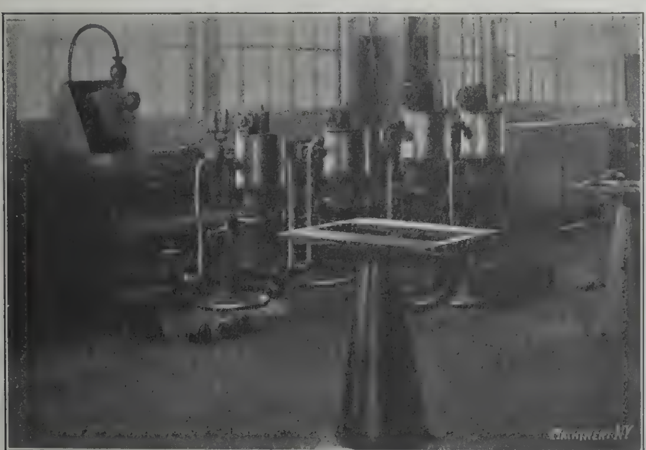


Fig. 25. Testing the Air Pumps

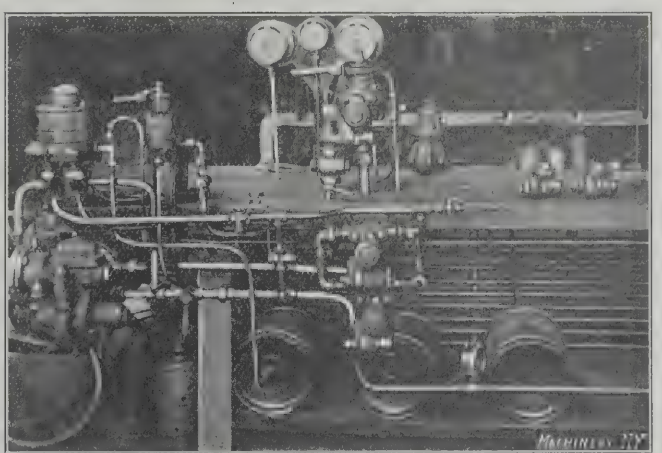


Fig. 26. Valve Testing Apparatus

Fig. 27. Supporting Air Drill with Portable Track and Trolley

Fig. 28. Portable Crane which is fastened to the Steam Dome

der compresses the grease into the mold and the lower cylinder is used to push the finished cake up out of it.

For various purposes the telescoping drill sockets shown in Fig. 23 are very useful and dozens of them are in constant use or kept in stock in the toolroom which is in charge of Mr. William Greilich.

An Unusual Babbitting Machine

In the tin and copper department in charge of Mr. W. J. Moffat, the method of babbitting some of the parts is unique,

Fig. 29. Riveting the Steam Dome to a Boiler with a Large Stake Riveter

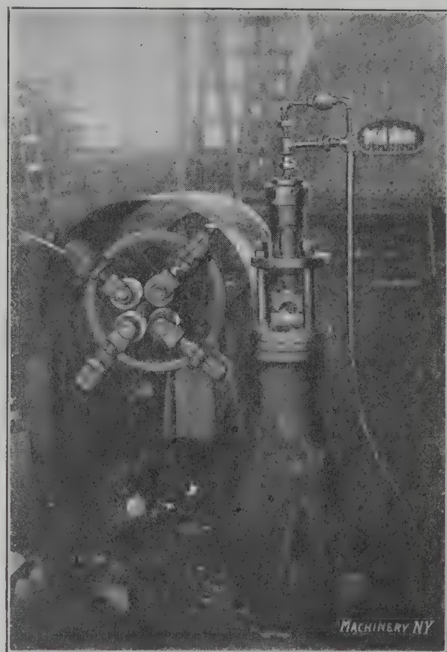


Fig. 30. Machines for Welding and Swaging Flues

Fig. 31. Forming Tool for Making Slash-bar Handles

and so far as I have been able to learn, original with Mr. Moffat. By referring to Fig. 21 it will be seen that the babbitting device used for brasses consists principally of a large iron pulley, flanged at the lower end and free to revolve on its center and around the outside rim of which are fastened at intervals the babbitting forms. The brass to be babbitted is

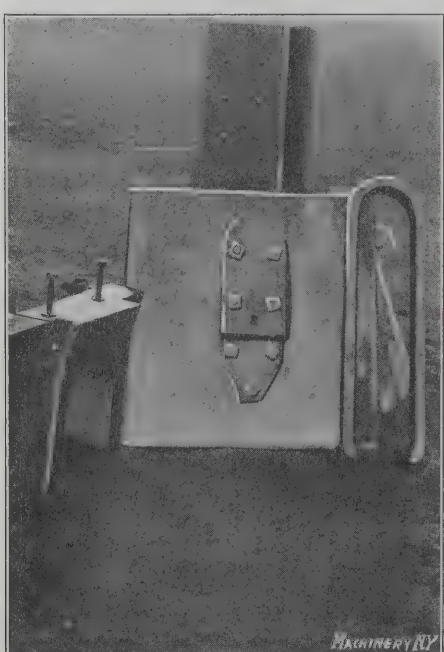


Fig. 32. Drawbar Pocket Bender

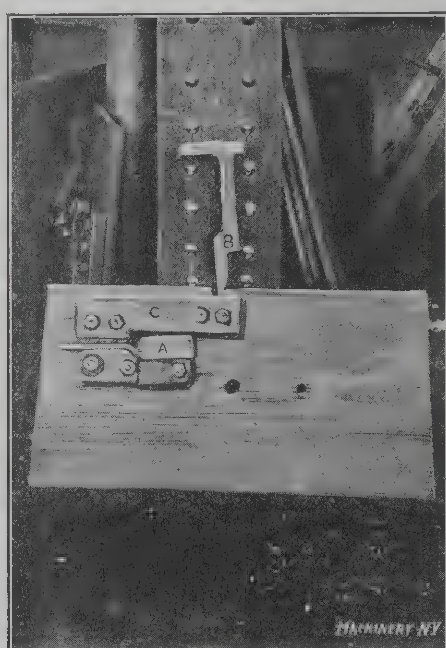


Fig. 33. Tool for Forming Twisted Pipe Clamps

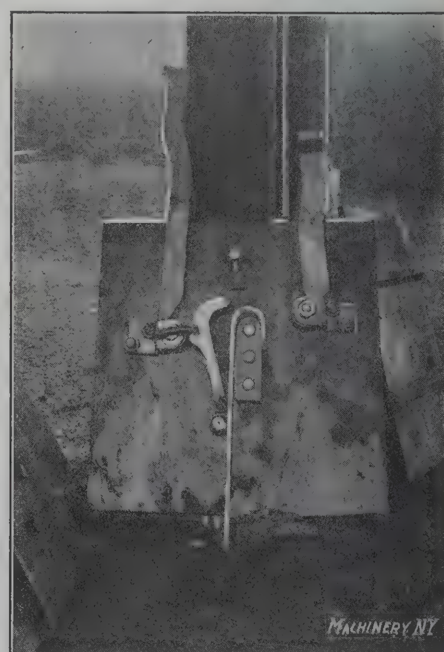


Fig. 34. Tool for Bending Safety Hangers for Brake Rods

set on end against one of these forms and the pulley or wheel revolved until the piece is opposite the air cylinder piston. After the contact bracket has been adjusted the air is turned on and the brass is pressed tightly against the mold. The babbitt is then poured in and a jet of air turned on the inside of the pulley rim opposite the hot metal quickly cooling it enough to allow the pressure to be taken off and the next piece swung into place. This machine is one of the speediest means of doing the class of work indicated that I have seen, and as practically all of the work done in this shop is piece work, it is speed that counts. In connection with piece work, it may be well to state here that there is no secret whatever as to the piece work rates and "books" similar to Fig. 24 consisting of hinged tin leaves with turned edges into which are slipped typewritten sheets of rates are placed in convenient places throughout the shop so that a workman or anyone else can learn in a moment what the rate is for any given piece. It is claimed that since the inauguration of the piece work plan here, that the work is turned out at 25 per cent less cost than in any other shop of the system and at the same time the men's wages have been increased from one-third to one-half over what they received when paid by the day. Of course the slow and dull men have of necessity been weeded out and the men now at work are active and alive to every kink that will save time without lessening the efficiency. Personally I was greatly impressed with the business-like movements of the men in every department.

The Air Brake Testing Apparatus

The air brake department which is placed at one end of the machine shop is very complete and the apparatus used for testing air pumps is shown in Fig. 25. As the engraving indicates four pumps may be tested at once. In the foreground

is shown a very convenient stand with tilting table for pump work. Fig 26 shows the valve testing apparatus.

In the Boiler Shop

The boiler shop is in charge of Mr. J. H. Filcer, with Mr. Andrew Greene as assistant, and like the machine shop it is almost large enough to get lost in. The first thing one notices when entering it from the office or the machine shop is the big Chambersburg stake riveter, Fig. 29, and the next are the stepped up horses used for platform ends by the boilermakers; these as well as the tracks and trolleys used to support the air drills, are shown in Fig. 27. The method of sustaining these air drill supports by a bent brace over the boiler dome and adjustable braces bolted to one end of the boiler, is plainly shown. A counterweight balances the air motor by means of a cord running over two pulleys and through the loop of an iron bracket on the motor. Another very useful device is the crane fastened to the boiler dome (Fig. 28), which is easily put in place and has a semi-circular table of its own for the roller on the lower end of the supporting brace to run on.

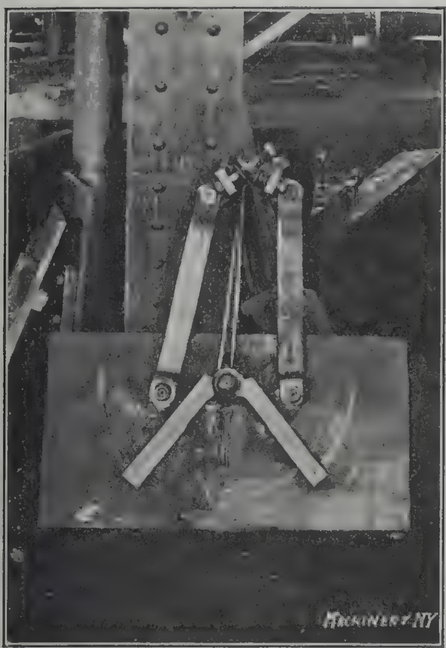


Fig. 35. Winged Former in which Cotter Pins are made

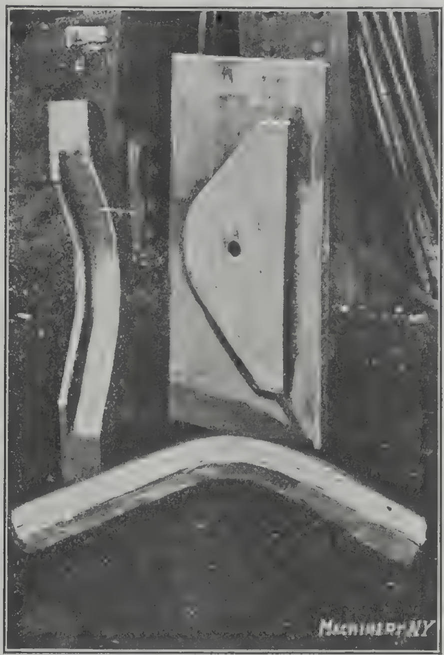


Fig. 36. Punch and Die for Bending Angle Iron

At the right in Fig. 30 is shown one of the most solid and compact pneumatic flue swages imaginable, while at the left is a regular standard flue welder of the roller-contact type.

Special Bulldozer Bending Forms

There are several well-made bulldozer forming devices in the forging department, which is in charge of Mr. H. D. Wright. One of these, the former used for making handles for slash bars, etc., is shown in Fig. 31. This former needs but little explanation as it can at once be seen that in use part *A* wedges over the hinged part *B* making the first half of the bend, which is immediately finished by part *C*, the end of which is hinged and is forced around by the formed stop *D*, leaving the handle finished as shown.

Fig. 32 is a drawbar pocket bender which differs from most of those recently shown in having the forming head of one solid piece instead of with wings. The gibs on the ends of the drawbar pocket are formed in an Ajax forging machine.

Twisted pipe clamps *A*, Fig. 33, are formed by the punch *B* passing under the part *C* and the sharp edge striking the upper edge of the hot iron, bending it over as shown.

Safety hangers for driver brake rods are made on a former (Fig. 34), which is very similar to Fig. 31, except that the final bend is straight instead of curved, as in the first instance.

Cotter pins are made on a winged former (Fig. 35), and angle iron is bent with a punch and die shaped as in Fig. 36.

The pneumatic bulldozer shown in Fig. 37 is a splendid machine for light bending as it is arranged with a permanent head and foot block so as to take easily-made forming punches and dies. By using these blocks formers of any ordinary shape for simple bending can be quickly made out of scrap metal under the steam hammer, clamped in place and several hundred pieces run out while a blacksmith would just be getting warmed up to the job.

Fig. 38 shows a big block ready to be forged under one of the steam hammers, the method of holding and handling being about the same as elsewhere.

* * *

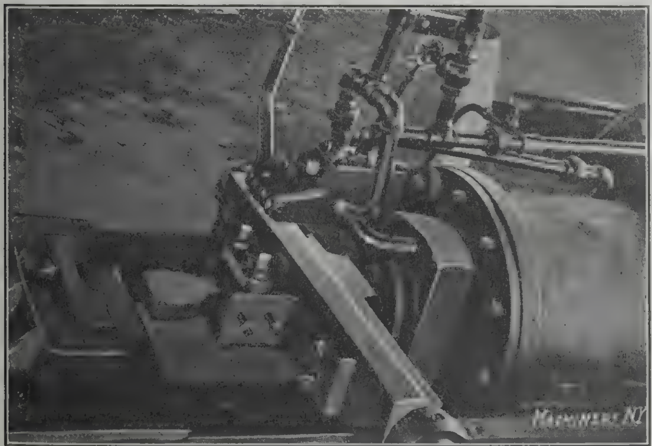


Fig. 37. Pneumatic Bulldozer for Light Work

Fig. 38. Method of Handling a Big Forging in the Blacksmith Shop

The electrical operation of an experimental section of the Swedish state railways for a number of years in order to ascertain the possibilities of economical electric operation in a country with abundant water power which can be used for generation of current, has proved so satisfactory that the administration of the state railways has decided to electrify the line between Kiruna and the Norwegian border. The distance is about eighty miles, and the traffic consists mainly of iron ore transported from the ore fields of Kiruna and Gellivara to the port of Narvik on the Norwegian coast. This is the most northerly railway in the world, it being entirely north of the polar circle. Two electric express locomotives and twelve freight locomotives have already been ordered, and the state is to proceed immediately to build the required hydro-electric plants. The total cost of electrification, including equipment, is estimated at $3,400,000.

* * *

A chair in aerial navigation has been established at the East London College of the London University. Prof. A. P. Thurston will have charge of this department and lecture on aerial navigation and subjects connected with this science.

THE DESIGN OF HEAVY HELICAL SPRINGS FOR RAILROAD CARS

EGBERT R. MORRISON*


Egbert R. Morrison†

A helical spring for railroad service is almost invariably made of round bar spring steel. The analysis of spring steel most frequently used is known as P. R. R. analysis, and its composition is as follows: Carbon, 1.0 per cent (not under 0.90 per cent); phosphorus, 0.05 per cent (not over 0.07 per cent); manganese, 0.25 per cent (not over 0.50 per cent); silicon, not over 0.10 per cent; sulphur, not over 0.03 per cent.

For spring steel of this character the maximum fiber stress should not be over 80,000 pounds per square inch, and the torsional modulus should be taken as 12,600,000 pounds. In the following discussion these values will be used where numerical substitution is made.

A spring is usually specified by three dimensions, although some specfications complete the design by a fourth. The dimensions usually given are the outside diameter, free height, and diameter of bar. The fourth dimension, the solid height, is not generally given, so that the actual design of the spring is really left to the manufacturer. In some cases the number of coils or "rings" is specified, but this should never be done, as a tapered coil may be considered by one as a full coil and by another as a partial coil, thus causing confusion.

Investigation of such formulas as are found in the general text-books, hand-books, and books of reference, indicates the need of more direct formulas to facilitate the design of springs. It is the writer's intention to present the derivation of such formulas with parallel examples, showing the ease of application. For this purpose we adopt the following notation:

d = diameter of bar,
D = mean diameter of coil,
f = total deflection,
h = solid height,
H = free height,
L = blunt length of bar,
W = weight of bar, or spring,
P = capacity of coil,
P_1 = any load less than capacity,
h_1 = height of coil under load P_1,
S = maximum fiber stress,
G = torsional modulus,
w = weight of steel per cubic inch.

Only round bar coils will be considered.

I. Length of Bar when Solid Height is Given

$$\text{Total number of coils} = \frac{L}{\pi D}.$$

$$\text{Total number of coils} = \frac{h}{d}.$$

Hence,

$$\frac{L}{\pi D} = \frac{h}{d}.$$

$$L = \pi\left(\frac{D}{d}\right)h = 3.1416\left(\frac{D}{d}\right)h$$

Example: Outside diameter = 4⅜ inches,
Bar = 7/16 inch,
Solid height = 10 inches.

$$L = 3.1416 \times \left(\frac{3\frac{15}{16}}{\frac{7}{16}}\right) \times 10 = 282.74 \text{ inches.}$$

II. Deflection when Solid Height is Given

Fundamentally, as given in most text-books,

$$f = \frac{LDS}{Gd}.$$

But

$$L = \pi\left(\frac{D}{d}\right)h$$

Hence,

$$f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h.$$

Or, for steel springs,

$$f = 0.019946\left(\frac{D}{d}\right)^2 h$$

Example: Outside diameter = 4¼ inches,
Diameter of bar = ¾ inch,
Solid height = 10 inches.

$$f = 0.019946\left(\frac{3\frac{1}{2}}{\frac{3}{4}}\right)^2 \times 10 = 4.34 \text{ inches.}$$

III. Ratio Between Free and Solid Heights

$$H = h + f$$

$$f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$$

Hence,

$$H = h + \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$$

$$H = \left[1 + \frac{\pi S}{G}\left(\frac{D}{d}\right)^2\right] h$$

Or, for steel springs,

$$H = \left[1 + 0.019946\left(\frac{D}{d}\right)^2\right] h$$

and

$$h = \frac{H}{1 + 0.019946\left(\frac{D}{d}\right)^2}$$

Example 1: Outside diameter = 6 inches,
Diameter of bar = 1⅛ inch,
Free height = 13¾ inches.
Find solid height h.

$$h = \frac{13.75}{1 + 0.019946\left(\frac{4\frac{7}{8}}{1\frac{1}{8}}\right)^2} = 10 \text{ inches.}$$

Example 2: Outside diameter = 7⅛ inches,
Diameter of bar = 1⅛ inch,
Solid height = 10 inches,
Find free height H.

$$H = \left[1 + 0.019946\left(\frac{6}{1\frac{1}{8}}\right)^2\right] \times 10 = 15.67 \text{ inches.}$$

IV. Deflection when only Free Height is Given

$$f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$$

But

$$h = \frac{H}{1 + \frac{\pi S}{G}\left(\frac{D}{d}\right)^2}$$

Hence,

$$f = \frac{\frac{\pi S}{G}\left(\frac{D}{d}\right)^2 H}{1 + \frac{\pi S}{G}\left(\frac{D}{d}\right)^2}$$

$$f = \frac{H}{1 + \frac{G}{\pi S}\left(\frac{d}{D}\right)^2}$$

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Or, for steel springs,

$$f = \frac{H}{1 + 50.1337\left(\frac{d}{D}\right)^2}$$

Example: Outside diameter $= 5\frac{1}{2}$ inches,
Diameter of bar $= 1\frac{3}{8}$ inch,
Free height $= 11\frac{3}{4}$ inches.

$$f = \frac{11\frac{3}{4}}{1 + 50.1337\left(\frac{1\frac{3}{8}}{4\frac{1}{8}}\right)^2} = 1\frac{3}{4} \text{ very nearly.}$$

V. Weight When Solid Height is Given

Area of cross section, $\frac{\pi d^2}{4}$.

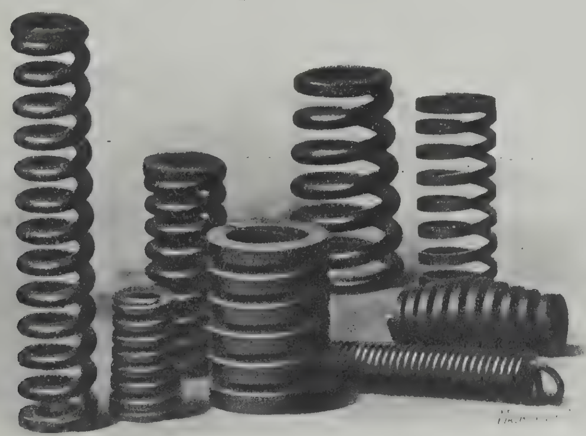

Fig. 1. Types of Coil Springs for Railroad Cars

Cubical contents of bar, $\frac{L \pi d^2}{4}$.

Then $W = \frac{L \pi d^2 w}{4}$

But $L = \pi \left(\frac{D}{d}\right) h$

Hence, $W = \frac{\pi^2 w}{4} d D h$

Fig. 2. Concentric Coil Springs for Railroad Cars

For steel springs, where one cubic foot of steel weighs 486.6 pounds,

$$W = 0.694\, d\, D\, h.$$

Example: Outside diameter $= 3\frac{3}{4}$ inches,
Diameter of bar $= 15/16$ inch,
Solid height $= 10$ inches.

$$W = 0.694 \times \frac{15}{16} \times 2\frac{13}{16} \times 10 = 18.3 \text{ pounds.}$$

VI. When Free and Solid Heights are Given to Determine Stress

$$h = \frac{H}{1 + \frac{\pi S}{G}\left(\frac{D}{d}\right)^2}$$

$$S = \frac{(H - h)\, G}{\pi h} \times \left(\frac{d}{D}\right)^2$$

$$S = \frac{G}{\pi}\,\frac{f}{h}\left(\frac{d}{D}\right)^2$$

For steel springs,

$$S = 4{,}010{,}700\,\frac{f}{h}\left(\frac{d}{D}\right)^2$$

Example: Outside diameter $= 4\frac{1}{2}$ inches,
Diameter of bar $= \frac{1}{2}$ inch,
Free height $= 22\frac{3}{4}$ inches,
Solid height $= 10$ inches.

$$S = 4{,}010{,}700 \times \frac{12.75}{10}\left(\frac{0.5}{4}\right)^2 = 80{,}000 \text{ pounds.}$$

VII. When Free and Solid Heights are given to Determine Capacity

$$P = \frac{S \pi d^3}{8 D}$$

and

$$S = \frac{G f}{\pi h}\left(\frac{d}{D}\right)^2$$

Hence,

$$P = \frac{G f d^5}{8 h D^3}.$$

For steel springs,

$$P = 1{,}575{,}000\,\frac{f d^5}{h D^3}$$

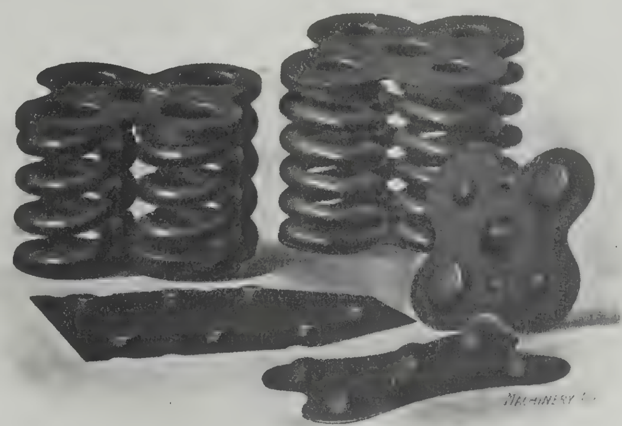

Fig. 3. Groups of Coil Springs held together by Plates at Top and Bottom

Example: Outside diameter $= 2\frac{7}{8}$ inches,
Diameter of bar $= \frac{1}{2}$ inch,
Free height $= 14\frac{1}{2}$ inches,
Solid height $= 10$ inches.

$$P = 1{,}575{,}000 \times \frac{4.5 \times 0.5^5}{10 \times 2.375^3} = 1{,}653 \text{ pounds.}$$

These last two formulas are very useful in ascertaining the stresses and loads of the separate coils of double and triple coil springs.

VIII. Given the Free Height, Diameter of Spring, Diameter of Bar, and a Specific Load to Carry at a Specific Height, to Find Proper Solid Height

$$\frac{P_1}{P} = \frac{f_1}{f}$$

$H = f + h$

$H = f_1 + h_1$

Hence, $f_1 = f + h - h_1$

Then $P\,(f + h - h_1) = P_1 f$

Hence $h = \frac{P_1 f - P f + P h_1}{P}$

$$h = \frac{P_1 - P}{P} \times f + h_1$$

But $f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$

Hence,

$$h = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2\left(\frac{P_1 - P}{P}\right) h + h_1$$

$$h = \frac{h_1}{1 + \frac{\pi S}{G}\left(\frac{P - P_1}{P}\right)\left(\frac{D}{d}\right)^2}$$

For steel springs,

$$h = \frac{h_1}{1 + \left(\frac{P - P_1}{P}\right) 0.019946 \left(\frac{D}{d}\right)^2}$$

Example: Outside diameter = 5½ inches,
Diameter of bar = ¾ inch,
Free height = 18 inches.

What solid height is required for carrying 1,395 pounds at 14 inches?

$P = 2{,}790$ pounds by formula $P = \frac{S \pi d^3}{8 D}$.

Then,

$$h = \frac{14}{1 + \left(\frac{2790 - 1395}{2790}\right) 0.019946 \left(\frac{4\frac{3}{4}}{\frac{3}{4}}\right)^2} = 10 \text{ inches.}$$

IX. To Determine the Quality of the Steel

The value of G is the index to the quality of the steel, and upon this value depend all properties of the spring. By transposing either the formula given in (VII) for capacity, or that for load, we find a method for ascertaining this value, *i. e.:*

$$G = \pi S \frac{h}{f}\left(\frac{D}{d}\right)^2$$

or

$$G = 8 P \frac{h D^3}{f d^5}$$

Example: Outside diameter = 4⅞ inches,
Diameter of bar = 11/16 inch,
Load = 1,219 pounds,
Deflection = 3.7 inches,
Solid height = 10 inches.

$$G = 8 \times 1219 \times \frac{10 \times (4\frac{3}{16})^3}{3.7 \times (\frac{11}{16})^5} = 12{,}600{,}000.$$

General Remarks

Concentric coils, as shown in Fig. 2, are made generally of the same free and solid heights. Presuming that such coils are all made of the same quality of steel, the ratio of $\frac{D}{d}$ should be the same throughout, for the formula in (II) clearly shows that this is necessary to obtain equal stresses in all coils.

The formula in (I) shows that after all values of $\frac{D}{d}$ are made the same, the lengths of all bars will be the same before tapering. A study of all the formulas reveals the fact that the ratio of $\frac{D}{d}$ determines everything; this ratio might well be called the *spring index.*

The absolutely perfect design of concentric springs is seldom possible where a scale of sixteenths inch for dimensions is used, with the customary one-eighth inch between inside diameter of one spring and outside diameter of the next. As cases of perfect design, however, the following springs are given as examples:

Spring No. 1

Outer: 5 inches outside diameter, 15/16 inch bar.
Inner: 3 inches outside diameter, 9/16 inch bar.

Where $\frac{D}{d} = 4\,1/3$.

Spring No. 2

Outer: 2⅝ inches outside diameter, ⅜ inch bar.
Inner: 1¾ inch outside diameter, ¼ inch bar.

Where $\frac{D}{d} = 6$.

In concentric coil springs where perfect design is impossible, the coil having the least value of $\frac{D}{d}$ will be stressed the highest, as shown by the formula in (VI); this coil may therefore be called the governing coil, inasmuch as the motion, or deflection, of the spring as a whole depends upon this coil. To estimate the capacity of such concentric coils we have recourse to the formula in (VII), while the formula in (VI) shows the separate stresses. The load which the concentric spring will carry at any height is then found by the fact that all loads are proportional to deflection.

In actual design adjacent coils are wound in opposite directions to prevent binding, as shown in Fig. 2. Instead of using concentric coils, groups of similar coils are sometimes used which are held together by pressed steel or cast spring plates, as shown in Fig. 3. It is customary to suspend the static load at one-half the deflection.

* * *

RAILWAY EDITION OF MACHINERY

Railway Machinery, which has been published for the past eight years as a special edition of Machinery will hereafter appear in the present form, that is, as the railway edition of Machinery, and the name Railway Machinery as the name of the edition will be dropped. The railway edition will contain sixteen or more pages on locomotive design and construction, railway shop practice and related matters, in addition to the purely general machine shop practice, machine design and other articles appearing in the regular edition.

The combination of railway shop practice, locomotive design, general machine shop practice and descriptions of new tools and appliances will make a journal peculiarly well fitted for superintendents of motive power, master mechanics, railway machinists and others interested in advanced railway machine shop practice.

* * *

An indication of the enormous cost of eliminating railroad grade crossings in cities and towns is found in the following announcement of the changes that will be made by the Pennsylvania Railroad Co. in doing away with ten grade crossings in Bristol, Pa. The present line of the Pennsylvania R. R. through Bristol is on a heavy grade running through the center of the city. The new line will go straight through the western part of the city. This change will eliminate two curves of 1 degree 20 minutes and 1 degree 40 minutes, respectively. The new line will be located about one-half mile west of the present station and will be 2¼ miles long and will necessitate the reconstruction of about nine miles of track. The maximum curvature will be about 45 degrees and the total curvature will be 50 degrees 8 minutes as against 101 degrees 22 minutes in the old line. Nine bridges were built over streets and public roads, one over the Pennsylvania canal and three over streams, making thirteen in all. The bridges required the grading of 550,000 cubic yards of earth, the building of 5,000 cubic yards of arch masonry and 1,200 cubic yards of bridge masonry. All the bridges were built of concrete and reinforced over all the streets to provide solid floors for tracks. The ten grade crossings in the center of the city are all done away with in the main line. The company has in the past ten years been eliminating grade crossings on its main line as rapidly as practicable, and in that time on the New York division alone has abolished 78 crossings, which with the number abolished in Bristol makes a total of 88 grade crossings eliminated to date.

* * *

Vertical shafts of considerable length are perhaps met more frequently in pumping installations than in any other application of the electric motor. The equilibrium of rotating vertical shafts has proved itself for various reasons more unstable than that of horizontal shafts. There is consequently present in these shafts, as soon as they reach any considerable length, a decided tendency toward vibrations. Such vibrations during protracted periods are always ruinous to electrical apparatus, and the electrical engineer should insist upon having his motor protected by a flexible coupling of good design that positively will not transmit the vibrations.

CONSTRUCTION AND WORKING OF BALANCED COMPOUND LOCOMOTIVES IN HUNGARY

CHARLES R. KING*

From the working results obtained from them, few European locomotives of any system are more interesting to superintendents of motive power than are the new balanced compound locomotives employed on the State railways of Hungary. For efficiency and economy they have proved to be equal, if not superior, to the famous "Adriatic" balanced compound locomotives of Italy, and although of relatively small size, the weight being only 73.7 tons, or 81.75 tons fully loaded, they pull a car load of 447 U. S. tons, or a gross load of 581 tons, at an average speed of 61.2 miles per hour for a distance of 133 miles, inclusive of a dozen slacks and stops representing a total distance of 11 miles that are actually run without steam in the cylinders in order to reduce the speed, which, without these interruptions, would be 64.5 miles per hour for the whole distance.

These new engines merit notice for their extraordinary pulling capacity with heavy train loads, at high speeds on the level, equal to a gross load, in round figures, of 600 tons the run being at a continuous rate of speed of a little over 60 miles per hour for approximately two hours. With a gross load of 580 tons, the weight on the engine draw-bar, train and tender included, is 6.2 times the weight of the engine itself in average load condition, and this tractive capacity at the speeds named is superior to the like capacity of any other European locomotives of any system whatever. Such results are exceptional, even for modern compound locomotives, and they show that the cylinder proportions, the valve and valve settings must be singularly well adapted for high speeds with high tractive power combined. The explanation of such efficiency, certainly unexcelled by any other locomotive in Europe, is clearly traceable to the design of the cylinder and valve motions; for all other conditions are opposed to the attainment of such velocities with a load of 6 times the engine weight.

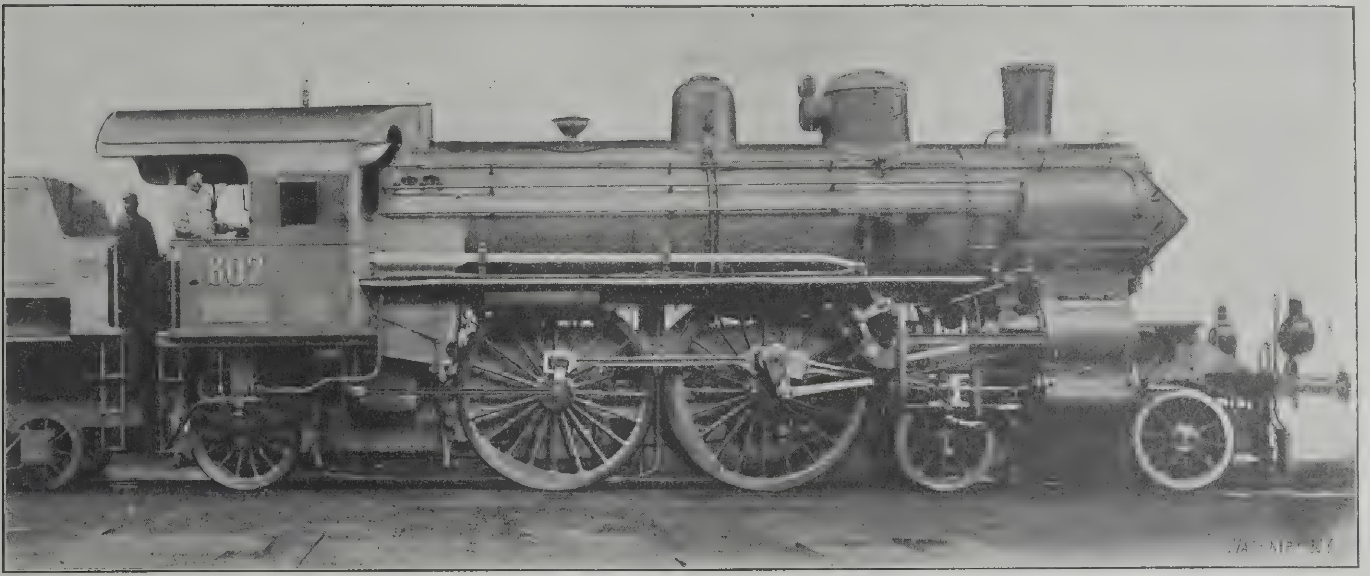

Fig. 1. Light-weight Heavy-duty Express Locomotive—Hungarian State Railways. Gross Load Hauled 600 Tons. Average Speed 60 Miles per Hour

In effect, the adhesive weight is inadequate for the loads hauled; that is, only 34.8 tons with a maximum boiler charge and which, on the road, would average about 31 tons adhesion. The coal used evaporates only 5.5 to 6 pounds of water per pound of fuel; the coal is therefore heavy in weight for the amount of steam it generates, and the tender is arranged to carry a load of 8 4/5 tons of this fuel. The tender is exceptionally heavy when loaded (52 tons), so the total weight of the entire locomotive is about 134 tons. The general conditions are not of a nature to favor very fast running with heavy loads, and, in addition, the air resistance to the

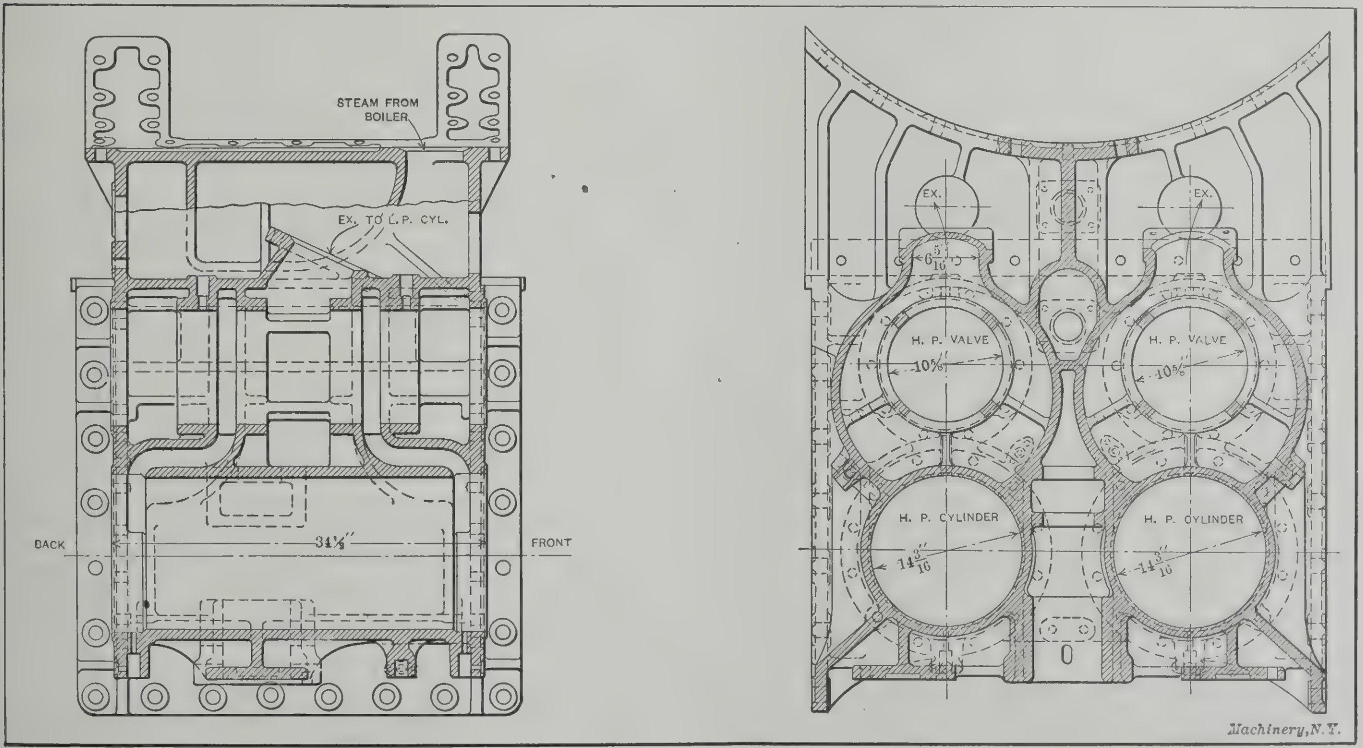

Fig. 2. Transverse and Longitudinal Sections of High-pressure Cylinders

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surface of the cars is greater than that usual in many countries of Western Europe, where, as notably in France and England, the cars are of diminutive size and do not offer the same resistance to high speeds. The Hungarian cars are both wide and high—as is usual in the central states of Europe.

The results obtained with these locomotives were realized with regular trains; and automatic records of the runs were made on several occasions by means of a fully installed dynamometer car attached to the train; and from those records the data presented herewith were obtained.

During the first tests of these locomotives in regular service on the Budapest-Pressburg line a car load of 392 tons was run on the level at a continuous speed of 69 miles per hour, the power developed being 1,870 horse-power, or 7.3 horse-power per square meter of heating surface. With two cars attached, the rate of 87.8 miles per hour was reached within 4 minutes after the opening of the throttle, and the highest speed subsequently attained on the level was 94 miles per hour. With a car load of 445 tons, the speed of 62.5 miles per hour is usually attained within 5½ minutes of the start, if the line is straight and practically level. From the automatic speed records in the writer's hands, the maximum capacity of the engine under consideration is shown while ascending a series of grades, the speed on one grade of 3.35 per thousands being 62.5 miles per hour with a gross load of 580 tons. With the exception that the water level is allowed to fall when this relatively small engine is running up grade at this speed with such a load, the engine appears, thanks to the double-expansion of the steam, to be in no way forced. It arrives in Budapest after a three hours' run with a gross load, including the weight of passengers and baggage, of close to 600 tons, in the very best trim, and quite capable of making the return run if that were required.

With an adhesive weight of only about 30 tons below its four driving-tires, the most remarkable fact calling for notice is the rapid acceleration of speed, not only after every dead stop but after each slowing down for adverse signals. With a slow acceleration—common to single expansion engines—the engine could not possibly maintain such high average and commercial speeds. The great potential power of the engine can, therefore, only be utilized by means of an efficient sand-jet, which is operated when starting away or in accelerating after a "slack." The long cut-off of the compound system enables the engine to run freely without the same wire-drawing as in simple engines, and to throw the full load of its steam on the cranks when they are at the angle of their greatest power—contrary to the practice with 4-cylinder non-compound engines. The engine is especially economical in steam. The boiler pressure ranges, when running, from 230 to 220 pounds. The throttle is opened nearly full; the admission or cut-off to all four cylinders alike is usually about 45 per cent, but never exceeds 50 per cent, even when starting, or descends below 30 per cent, when on a down grade—and this refers to loads up to nearly 600 tons.

A noteworthy characteristic which marks the operation of this locomotive is the receiver steam-pressure, which hardly varies during a three hours' run except between the limits of 73 and 68 pounds per square inch. It is apparently to this high receiver pressure, of nearly one-third the boiler pressure, and admitted to low-pressure cylinders having about three times the area of the high-pressure cylinders, that the steam economy of this locomotive is to be ascribed.

Such practice is entirely opposed to the old idea—unfortunately still largely current—that the back pressure must be reduced in order to enable engines to attain high speeds. To reduce this back pressure it has been usual to give the low-pressure valves a considerable lead on the high-pressure valves; that is, if the high-pressure cut-off is 30 per cent, 60 per cent is allowed for the low-pressure valves, the result being that the back pressure, the receiver pressure, the initial low-pressure cylinder pressure and the low pressure mean effective pressure, all at the same time, drop so low that the low-pressure cylinders only develop one-quarter or one-third of the total power output, and the efforts in the two pairs of cylinders are then both unequal and unbalanced, thus rendering the engine liable to slip and throwing away the advantages of an economical two-stage expansion. On the English Great Western Railway we may see the so-called "balanced" compound locomotives work with cut-offs of 30 to 60 per cent, respectively, in the two groups of cylinders, the consequence being that out of a boiler pressure of 225 pounds only 25 pounds is reserved for the low-pressure cylinders. Naturally, such engines are found to be the reverse of economical—although the reason for this commonly appears to be little known, and least of all to those who imported these compound engines. The enginemen working these machines understood the compound system so little that the first English driver operating them thought it best to put the low-pressure valve motion in full forward gear in starting the train and leave it there for the rest of the trip. The engines thus worked consumed 8 per cent more fuel than the single-expansion engines working the same traffic. The result was attributed to the uneconomical system of double-expansion in general. If the drivers were not at fault then the trouble must surely have been with the system employed.

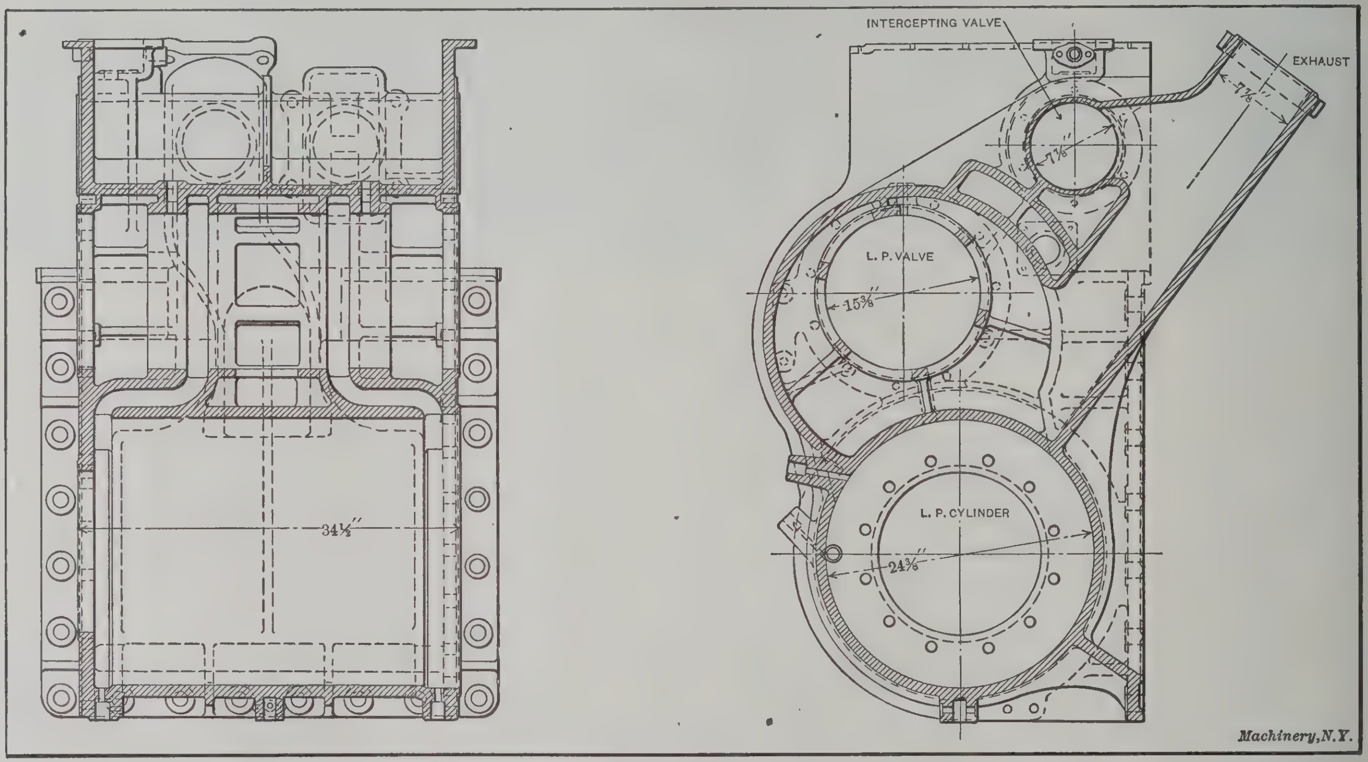

Fig. 3. Sectional Views of One of the Low-pressure Cylinders

The locomotives of the Hungarian State Railways were being designed by Messrs. Paul Roth and Hubert Dvörak, chief mechanical engineers of the State Engineering Works, at Budapest, in the year 1903, when the writer first had the opportunity of examining the details of the engines ("Class 802"), then on the drawing boards, and of discussing the suitability of piston valves for balanced compound engines—concerning which opinion in Europe had not been definitely fixed by the trials then in course on the Eastern of France Railways with piston valves for all cylinders alike. In awaiting the settlement of this question, the construction of the type "802" appears to have been deferred. At that time (1903) the express traffic of the Hungarian State lines was operated by tandem-compound engines of the Woolf type ("Class 31"), and by two-cylinder compound six-connected locomotives, "Class 40." An experiment had also been made with the "Atlantic" type of engines, of which one was a compound with flat valves and one a single-expansion with piston valves. To observe the working of these two machines, the writer had journeyed to Budapest. However, contrary to a statement that has been made in these pages upon the compound locomotive, neither class was perpetuated. In passing, it may be observed that the Hungarian railways were among the first to experiment with piston valves (about 1878), although the practice was discontinued.

The general mechanical characteristics of the heavy-duty, express, balanced-compound engines ("Class 802") of the Hungarian railways are: Atlantic wheel type, balanced compound engine with all cylinders bolted together in one line below the front end of the boiler; all main rods driving direct on one and the same balanced axle; low-pressure cylinders outside, having 2.98 times the area of the small cylinders; separate piston valve for each cylinder and one valve-motion for each pair of cylinders, the inside valves being driven from the outside valve gear through horizontal rockers of the type introduced on the English North-Western Railway for the first 4-cylinder compound engines of the late Mr. Webb—the prototype of the Central European locomotives of the present day.

The Hungarian compounds are, therefore, as simple in design as were the Webb engines. They have no moving parts which could be dispensed with in any engine, simple or compound; they have the same number of cylinders, and they are infinitely less complicated than are the 4-cylinder simple engines of the English Great Western Railway, and this by reason of the straight forward cylinder disposition.

In one respect these compounds differ from the generally-approved practice of the day, in being fitted with an intercepting valve—an organ which figures in nearly all Hungarian compound engines, although it is generally disapproved by the most eminent authorities on the compound system, including Mr. Mallet who, for his articulated locomotives, holds that it eliminates the especial advantage of his "steam-coupling;" that is, by intercepting the course of the steam from one group of cylinders to the other, it allows the engine to slip without any check, whereas in his purely-compound arrangement the slipping of one group is automatically arrested by the back pressure so created against the face of its pistons. Whether for Mallet engines or directly-connected engines, the intercepting valve is generally considered most undesirable, and it has been abandoned by nearly all countries of Europe, excepting France. The use of this intercepting valve is not apparent in the actual records of the express-train running (by "Class 802"), already referred to. Whenever steam from a boiler is admitted directly to all four cylinders, the receiver pressure necessarily becomes the same as that of the high-pressure valve-chest. On the contrary, the graphic details of running with loads of about 580 tons at 64 miles per hour average, by the Class 802, show that when the throttle is opened the receiver pressure is usually only 62 pounds per square inch and from which it rises regularly to the normal pressure of 73 pounds some few minutes later—unless, perchance, the boiler pressure should fall rapidly in hauling such heavy loads when ascending grades beginning immediately on starting, in which case the receiver pressure remains constant, while the boiler pressure falls; in other words, the power output of the high-pressure cylinders falls with the pressure, but the work of the low-pressure cylinders remains nearly constant and in excess of the amount developed in the high-pressure cylinders. From these graphic running indications it does not, therefore, appear that the intercepting valve is really employed.

The intercepting valve consists of a cylinder about 8 inches in diameter and 34 inches long, whose ports connect to the exhaust steam pipe from the high-pressure cylinders at one end and to the exhaust pipe from the low-pressure cylinders at the other end. (See details of the cylinder in Figs. 2 and 3.) The intercepting-valve stem is fitted with two piston-heads, 16 inches apart, and according as the pistons cover one or the other set of ports, the engine works compound or non-compound.

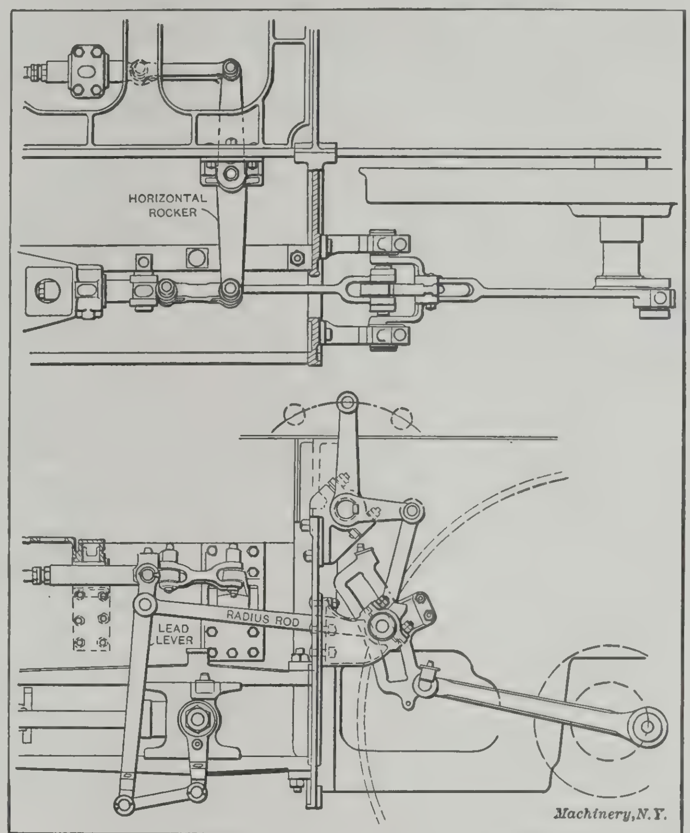

Fig. 4. Elevation and Plan of Valve Mechanism

The displacement of this valve is steam-aided, for the same lever by which the engineman operates the valve is also attached to a steam pilot-valve just over the intercepting valve, and this pilot-valve admits steam to one end of the intercepting valve and drives it forward against the pressure of the exhaust steam. The provision of an intercepting valve does not dispense with the usual adjunct of a supplementary steam admission to the low-pressure cylinders, when working compound from the start, and this live-steam to the low-pressure is, in most cases, found sufficient in starting trains rapidly and where, as is ordinarily the case, the valve-gear admits steam up to 90 per cent of the piston stroke.

Of intercepting valves in general, the leading expert of compound locomotive design in Europe, Herr Karl Goelsdorf, has expressed his conviction to the writer that their use may entail as much fuel loss as there is gain by two-stage expansion. Mr. Mallet, the originator of the intercepting valve, is absolutely opposed to its employment, and the latter engineer also considers that duplicate valve gears are positively harmful if a correct ratio of high-pressure and low-pressure cylinder volumes is adopted.

To allow of extra-high receiver pressures, the relief valve on the receiver of the Hungarian locomotives is set not to lift at pressures below 104 pounds; the usual limit is 82 pounds per square inch.

Air-suction valves are provided on all cylinders for running with closed throttle. At present the much-preferred system of connecting the two ends of the cylinder through a by-pass valve when the engine is drifting, has been mostly confined to superheated steam locomotives.

From Fig. 5 it will be observed that the Florian Angelé-Walschaert's valve gear is disposed with the radius rod attached to the lead-lever below the valve-stem according to the

usual manner for slide-valves or for piston-valves giving outside admission. This motion is reversed for the inside or high-pressure valves through the intermediary of the transverse rocking levers (see Fig. 4), and therefore gives internal or central admission to the inside valves.

The valves are illustrated in Fig. 5. The piston heads each consist of two disks of equal diameter, one-half of the disk engaging with a recess in the other half and the two halves held together by the nut on the valve stem, an arrangement which dispenses with junk rings. The valve rings or segments are easily inserted between the two disconnected halves. The rings are cut with Z-ends, thus forming a steam-tight joint. Inside of this packing ring is inserted a steel ring of round section having spur ends which are tightly sprung into holes recessed in the packing ring on either side of the Z-joint, as shown in the end view. The valve pistons are allowed vertical play on the valve stems, the piston being turned

as for instance 1:2.9 in American practice, 1:2.77 as in French practice or 1:1.9 in English practice.

With a cut-off of 30 per cent employed on a slight falling grade and with a gross load of 580 tons, the actual speed being 64 miles per hour, but increasing to 71 miles per hour—the mean effective pressure in the high-pressure cylinder is 77 pounds per square inch of piston area, and it is 26 pounds per square inch of piston area in the low-pressure cylinder. The mean load on each piston is about 12,200 pounds, with a tendency to overload on the low-pressure side. The average high-pressure back pressure—compression neglected—is 72.5 pounds per square inch. The initial low-pressure pressure is 70 pounds and the average low-pressure back pressure is 12.5 pounds, the exhaust nozzles being wide open.

By closing the intercepting valve so that the machine works simple expansion, and still maintaining the cut-off of 30 per cent (a cut-off employed for the most economical of simple

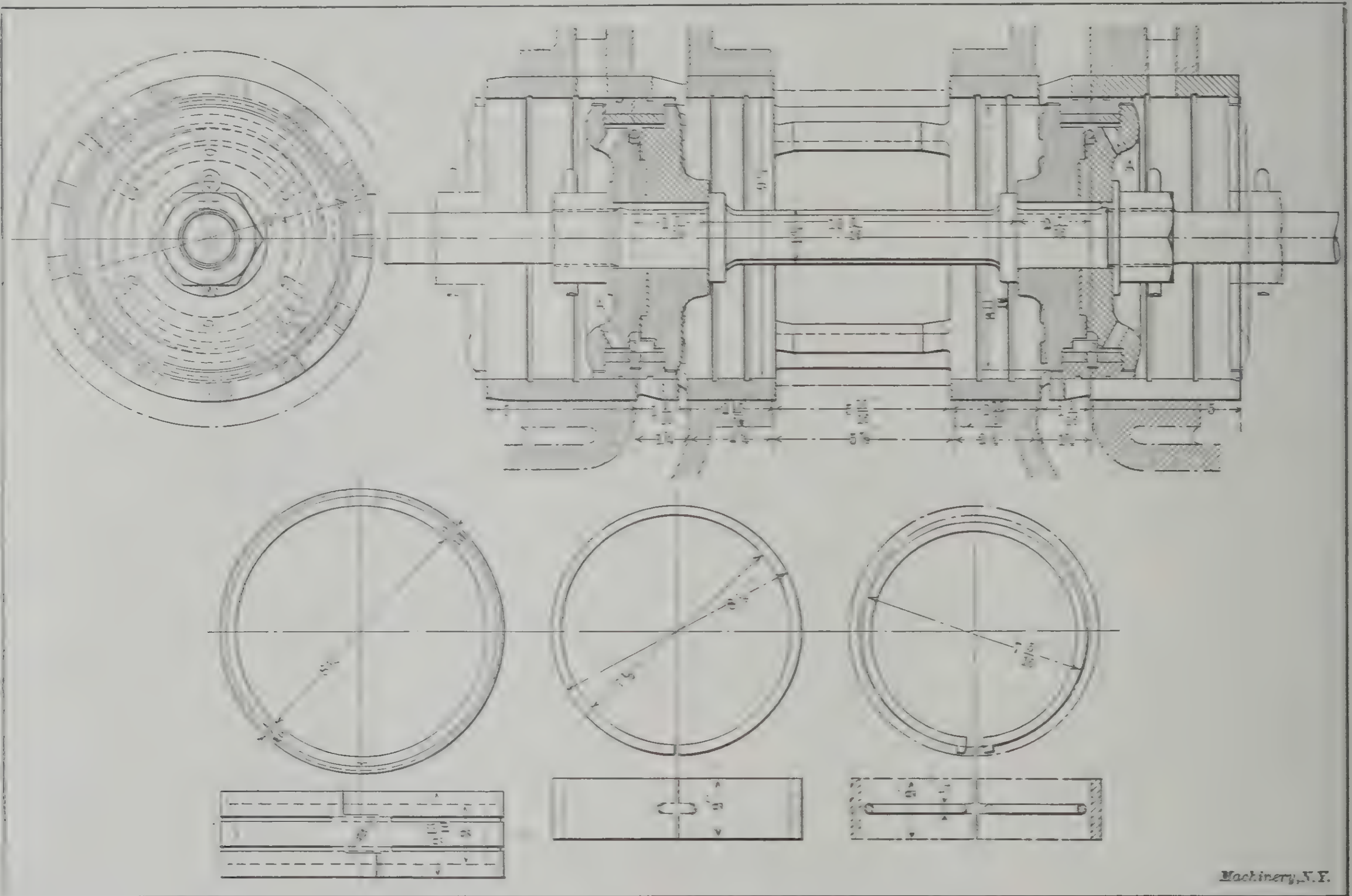

Fig. 5. High-pressure Piston Valve

down to a diameter 4 millimeters (5/32 inch) less than that of the hole in the disks. The valve stems are therefore relieved of all strains and merely push the valve heads without carrying any weight. The pressure of the steam on the outside surface of the valve rings is neutralized by steam admitted below them by means of six 10-millimeter holes (25/64 inch) drilled through from the inside face of the outermost of the valve disks. All rings are milled on their outside circumference with two 4-millimeter oil-grooves.

The lap of the valves is 38 millimeters (1½ inch) for the high-pressure and 43 millimeters (1 11/16 inch) for the low-pressure. The high-pressure lead is 7 millimeters (9/32 inch) and the low-pressure is line-and-line.

The high-pressure cylinders are 360 millimeters diameter (14 3/16 inches), with an area of 158.3 square inches, and the low-pressure cylinders are 620 millimeters, or 24 3/8 inches in diameter, with an area of 467.5 square inches. The stroke in each group is 660 millimeters, or 26 inches. The area of the low-pressure pistons is 2.98 times that of the high-pressure pistons, and a mean effective pressure in the low-pressure cylinders of about one-third of that in the high-pressure cylinders serves to balance the efforts in the two groups of cylinders. For a given back pressure on the high-pressure pistons, more work is effected in the low-pressure cylinders than is the case where the ratio of volumes is less,

engines on rising grades), it becomes possible to measure the amount of steam required in simple working with that in non-compounds having four cylinders 14 3/16 inches by 26 inches. Expanding the steam down to 10 pounds terminal with an average back-pressure of 12.5 pounds, the diagram area represents 102 pounds mean effective pressure, or about 24 per cent greater than is obtainable in double-expansion when using the same volume of steam as measured by the cut-off alone (clearance neglected).

The mean effective load on the piston is then about 16,200 pounds, or 24 per cent greater than when working compound; but the steam, now very completely expanded for single-stage working, is then exhausted to the air. In compound working the amount of work done in the high-pressure cylinder is duplicated by that performed in the low-pressure cylinder, so that the total expansion of the two cylinders is equal to a mean effective load on the two pistons of 24,400 pounds and this, compared with the result obtained under identical conditions by a single expansion of the same unit-volume of weight of steam taken from the boiler, is:

$$\frac{24{,}400 - 16{,}200}{24{,}400} = 33 \text{ per cent},$$

showing that in the same engine worked compound, instead of simple, the power production is 33 per cent greater for a given weight of steam

consumed or, inversely, 33 per cent less steam is used for a given power developed. On the other hand, for a given cylinder capacity, the engine is considerably more powerful in simple expansion because the simple engine can work non-expansively through a wide range of volumes, while as a compound the total amount of steam that the engine can absorb from the boiler is limited to one small pair of cylinders. This shows, therefore, the possible utility of the intercepting valve if the express engine were required for heavy switching or pusher work—a requirement so rare that for all ordinary heavy-duty express work, within the limits of the adhesive load, the intercepting valve becomes a superfluity.

In this Hungarian locomotive it will be observed that the low-pressure cylinder has 2.98 times the volume of the high-pressure cylinder. The smaller cylinder has a capacity of 100 and the large cylinder of $298 = $ total 398. The range of expansion is, therefore:

$$\frac{\text{total volume of two cylinders in series}}{\text{total volume of steam before expansion.}}$$

The whole clearance space volume of the high-pressure cylinder is here included in the initial steam volume of the cylinder, because every pound of negative work due to compression of the steam in the clearance spaces of the cylinders is subtracted from the work done by the engine, so that whether the ports and clearance are wholly filled with live steam direct from the boiler, or whether they are partially or wholly filled by means of energy expended in filling them during the period of compression, the work of filling them always inevitably falls on the boiler. For high speeds a 20 per cent high-pressure clearance volume is now found desirable in most compound and non-compound engines. This percentage of volume being added to the most economical cut-off of the Hungarian engine with a train load of about 600 tons at 60 miles per hour, that is, 40 per cent of piston stroke, the total initial steam volume becomes 60 per cent and the total volume of the small cylinder plus that of the large cylinder, becomes $120 + 298 = 418$, from which it appears that the effective range of expansion, initial steam volume to total volume, attained by the steam at the end of the low-pressure piston stroke, is $\frac{418}{60} = 6.9$. This is a practical working value and it is applicable to nearly every modern compound engine now at work in Europe. The conditions represented by such a ratio of expansion are highly economical. This value may be carried to 12 and 15 but such ranges of expansion are not desirable or economical. Enginemen used to running simple engines cling to the idea that if simple engines are able to run with 14 and 15 per cent cut-off, compound engines should certainly not be run with any more. In Italy, the writer has observed express trains, with a fair load, worked during a four hours' run with compound engines, at the running cut-off of 15 per cent, and attain very high speeds. The range of expansion was thirteen. It will be useful to compare these rates of expansion with those obtained in engines working non-compound. In this case the cylinder, divided into 100 per cent plus 20 per cent for clearance volume, has a total volume of 120. This sum divided by the very lowest practical cut-off with heavy trains, that is, 15 per cent, added to a clearance volume of 20 per cent, as before mentioned, gives a range of expansion of 3.4. Under equal conditions of clearance volume, a higher range of expansion is absolutely a practical impossibility in any locomotive that is worked in simple expansion, and hauling heavy express loads.

On the English Lancashire & Yorkshire Railway some four-cylinder non-compound engines have recently been introduced concerning which Mr. Hughes, in a recent paper read at the Liverpool meeting of the Institution of Civil Engineers, July, 1909, said: "The author also preferred a simple to a compound engine, owing to the greater range of expansion obtainable with express trains." If such a feat in steam expansion were possible, and a greater range of expansion than 6.9, as in the Hungarian or other compound engine, could be obtained, an analysis of the process would be highly instructive. Practically, it is impossible to obtain a higher than three effective expansions in simple locomotives having large clearance volumes. Allowing equal clearance volumes, as before, of 20 per cent, it is clear that it would be impossible to obtain an expansion of 6.9, because the volume of the clearance space alone, plus the cylinder volume, equals 120, which is six times the clearance volume alone without any allowance for steam in the cylinder.

The Hungarian engines are run with a lower steam consumption at average speeds of 64 miles per hour with loads of 580 tons, than is possible with any of the most economical simple engines that have ever been built in England. This fact is, however, not admitted by the chief mechanical engineer of the Lancashire & Yorkshire Railway who, in a circular dated August, 1907, states that "with very low piston speeds, single expansion is very wasteful * * * but a high piston speed with single expansion is as economical as compounding at low speeds." This statement is diametrically opposed to the practical experience obtained in all countries of Europe, including also that obtained with mediocre compound engines on the English Great Western Railway, and also to a statement made by the chief mechanical engineer of the road in response to a statement analagous to the above, made by the L. & Y. R. superintendent of motive-power at a meeting of the Institute of Engineers in 1906.

The unexcelled results obtained from the Hungarian engines are almost wholly attributable to a particularly suitable arrangement of the compound cylinders. In addition the engine is of very light weight for its power, this being made possible by the strength of the materials and the design of all the working parts. The lightness of the design is apparent in the illustrations shown. The only economy that could have been further effected in the weight would have been by the adoption of high-grade bar frames. The wheel centers are steel castings from the noted steel works of the State at Diósgyör and the tires of chrome nickel steel, are from the steel works of Resicza in Hungary. Steel castings—not "cast-steel" as steel castings are often erroneously termed—are largely employed in all parts possible. The steel works at Diósgyör are very partial to steel castings and for many years past have, in common with the Horwich works of the Lancashire & Yorkshire Railway, cast even the mud-rings and found them cheaper, though the form employed was rather intricate. In general, steel castings come out dearer than forged work at present, spoiled castings included, but their merit of lightness often outweighs the consideration of first cost. The crank axles of these engines are of the Z-type, forged in one piece from an ingot of nickel steel. The half-cranks are circular in form and thin in substance to allow the inside axle-boxes a good width for the journals. The axles are solid in this instance although the Diósgyör Works has for years forged hollow axles by means of a special press and plant for this work. The tender is the only example of the Vanderbilt system employed in Europe, and it is American in all its details.

* * *

Successful experiments have been made in Europe with a microphone invented by Messrs. C. Egnér and J. C. Holmström, engineers in the Swedish State Telegraph service. The use of this microphone immensely increases the distance over which telephonic communications are possible. A conversation between Stockholm and Berlin, the line including a considerable distance of submarine cable, has been possible without difficulty, and conversations have been held between the city of Sundsvall in the northern part of Sweden and Paris, a distance of 2,270 miles. Efforts are now being made to establish telephonic communications between Copenhagen and London, via Paris.

* * *

According to a consular report there are now fifteen factories in operation in Paris for the building of aeroplanes. Besides, there are at least a dozen inventors who are more or less secretly building individual machines embodying their more or less original ideas of what the aeroplane or dirigible airship of the future ought to be. As a matter of fact, the aeroplane industry appears to be growing almost as rapidly as did the automobile industry in the early stages of its existence.

BOILERS AND CHIMNEYS*†

A. WIND‡

The writer read with great interest the article entitled "Simple Method of Stack Design," published in the August, 1909, issue of MACHINERY. The expression "horse-power" of a boiler, used in this article, is an expression that is not customary in England. The term horse-power for a boiler seems to me very vague, because the boiler when used for two different types of engines would give a very great difference in the amount of power that may be obtained from it. A boiler, for instance, may be able to evaporate say 6,000 pounds of water per hour at 120 pounds working pressure. Assuming twenty pounds of steam for every horse-power, this boiler would be a 300 horse-power boiler; but if the boiler were supplying steam to an engine exhausting into the air and working under unfavorable conditions, 35 pounds of steam per horse-power might be required. In this case the boiler would be of only 170 horse-power. Again, a boiler may not be used for raising steam for engine driving, but it may be used for boiling purposes, as in paper mills, creosoting plants or celluloid works; then the term horse-power would convey an altogether wrong idea.

I find, therefore, that it is better to follow the custom used in England and on the Continent, of speaking of boilers as being built to evaporate so many pounds of water per hour under ordinary circumstances. At the works where the writer is employed this method of designating boilers applies as well to water tube, Lancashire, Cornish and multi-tubular boilers. Of course, it must be understood that a boiler being built to evaporate 6,000 pounds of water per hour when fired with good coal by hand, would be able to evaporate 8,000 pounds of water per hour, or thereabouts, when fired with a mechanical stoker and fed with pre-heated feed water.

[Our correspondent apparently has an erroneous idea as regards the meaning of a boiler horse-power, as this expression is used in the United States. The Centennial standard boiler horse-power adopted by the American Society of Mechanical Engineers in 1884, is defined as an evaporation of 30 pounds of water into dry steam under a pressure of 70 pounds per square inch above atmosphere from feed water at a temperature of 100 degrees F., or the evaporation of 34½ pounds of water from feed water at a temperature of 212 degrees F. into steam of the same temperature. This standard is equal to 33,305 B. T. U. per hour.—EDITOR.]

As regards the size of chimneys, the writer would say that the draft that is necessary for hand firing will almost without exception be sufficient when firing the boiler with an ordinary mechanical stoker. In the accompanying Data Sheet Supplement heights and diameters of chimneys for different kinds of boilers are given. This table is based upon the grate area of the boiler, assuming the burning of from 20 to 25 pounds of coal per square foot of grate per hour. The size of the grate in many instances will vary very little with the length of the boiler. In the works where the writer is employed the same grate is put into a Lancashire boiler 25 feet long as in one 30 feet long. This applies also to Cornish and multi-tubular boilers. When two or more boilers are worked together it is not necessary to calculate the size of the chimney for the total combined grate area of all the boilers, as it is very seldom that all the boilers are fired in all furnaces at exactly the same time. Therefore, a greater number of boilers permits of a comparatively smaller size of chimney. The table in the accompanying Data Sheet Supplement gives the diameters of boilers, grate areas and the diameters and heights of chimneys for any number of boilers from one to five, in the case of the Cornish type, one to fifteen in the case of the Lancashire type, and one to ten in the case of the multi-tubular boilers. In each case the height of the chimney is taken to be 20 times its diameter.

Where forced draft or induced draft plants are installed, the size of chimneys can, of course, be considerably reduced. Each given size of chimney would prove sufficient for 33 per cent greater capacity than shown in the table, when such draft is employed. To determine the size of the chimney for six boilers with induced draft, for example, select the chimney given in the table corresponding to four boilers.

The sizes of chimneys given in this table correspond to the ordinary practice in England and on the European continent. It may, of course, differ slightly from that customary in the United States, but the writer thinks that, nevertheless, this table may be of interest to steam engineers in America.

* See MACHINERY, August, 1909, engineering edition: Simple Method of Stack Design.
† With Data Sheet Supplement.
‡ Address: Woodfield Ave., Penn, Wolverhampton, England.

* * *

NEW YORK CENTRAL ADOPTS PENSION SYSTEM

President W. C. Brown of the New York Central & Hudson River Railroad announced on November 10 that three of the railroads in the Central system would begin paying pensions to their retiring employes on the first day of the coming year. The pension plan will affect about 100,000 of the employes of the Central and affiliated lines. It will involve the payment of about $500,000 a year. Employes of the New York Central & Hudson River Railroad Company, the Lake Shore & Michigan Southern Railroad Company, and the Michigan Central Railroad Company will be eligible, under certain conditions, for pensions under the present plan. Employes of the Pittsburg & Lake Erie and the other lines of the Central system will not be eligible. But the extension of the pension plan to all the other principal lines of the system is under consideration.

Under the plan as adopted, employes on reaching the age of 70 years are retired. If they have been continuously in the service of the company for at least ten years immediately preceding their retirement, they will be entitled to a pension. An employe who has been at least twenty years in continuous service and has become unfit for duty may be retired with a pension, even though he has not reached the age of 70 years.

The amount of the pension is 1 per cent, for each continuous year of service, of the employe's average annual wage during the ten years before his retirement. A conductor who has been earning 1,500 dollars during the ten years preceding his retirement and who has been in the company's employ for twenty consecutive years would thus receive 20 per cent of his annual 1,500 salary, or 300 dollars a year for the rest of his life. If the same conductor had been thirty years in the service he would get 450 dollars a year; if he had been forty years in the company's service he would get 600 dollars. A brakeman who had been earning 900 dollars a year for ten years, and who had been twenty years in the service, would get 180 dollars a year for the rest of his life. A trainman who had reached the age of 70 years, and who had been ten consecutive years in the service would get 10 per cent of the average annual wage which he had been receiving during that time.

The pensions are to be administered by a Pension Board composed of Vice-Presidents J. Carstensen, A. H. Smith, C. E. Schaff, and A. H. Harris of the Central; General Manager R. H. L'Hommedieu of the Michigan Central, General Supt. J. F. Deems of the M. P. R. S. & M. Railway, General Manager D. C. Moon of the Lake Shore & Michigan Central, and General Manager J. Q. Winkle of the C., C., C. & St. Louis Railway.

The final decision to give the pensions was reached at a meeting of the directors of the Central and affiliated lines. President Brown, J. P. Morgan, W. K. Vanderbilt, Sr., W. H. Newman, and Marvin Hewitt of the Chicago & Northwestern, who has recently entered the Central directorate and that of the other Central and affiliated lines, were present.

The pension system will reach from the lowest to the highest employe throughout the Central system. On January 1, 1,735 men are scheduled to receive old age pensions according to the plan. Up to this time the Board of Directors of the Central have been granting pensions to individual employes; but the new plan will involve the expenditure of about four times as much money as has hitherto been devoted to pensioning.

An old age pension plan on practically the same lines has been in operation on the Pennsylvania Railroad ever since 1900.

* * *

Don't think that a hack-saw blade is spoiled when one or two teeth are broken out of it; but you will soon ruin it unless you bevel off the teeth next to the broken one.

THE UNITED STATES CREAM SEPARATOR

ITS DESIGN AND MANUFACTURE

RALPH E. FLANDERS*

The village of Bellows Falls, Vt., was foreordained by Nature, when she laid out the geography of New England. For the past forty odd miles the Connecticut River has been pursuing a placid and unobstructed course, but here it finds the way barred by an outcropping ledge, set like a dam, between high hills on each side. Over and through this ledge the water has worn a rough, crooked passage. The first pulp mills were built here many years ago, the owners being drawn by the fine water power, and by the vast drives of spruce logs, which each spring are floated from far-away forests on the Canada border, to mills in this and other towns nearer the centers of civilization.

The town is famous for its bridges, as well as for its pulp mills. The latter are located on an island between the main bed of the stream and the power canal, which at ordinary times carries the greater part of the flow. Means of communication have to be provided to reach this island from both sides. Furthermore, the town is an important railroad center. The main Connecticut valley line of the Boston & Maine R.R. crosses the river here, the station being located on the island. An important branch of the Fitchburg division climbs down from the hills on the New Hampshire side, while a main line of the Rutland Railroad climbs up into the still higher hills of the Vermont side. All these lines of transportation, with the local electric car line, require no less than sixteen bridges in the little one-quarter mile square space about the island.

Among these bridges may be found fine examples of almost every one of the important types in use. Spanning the river above the island is shown, in Fig. 1, a famous two-hinged arch which was described in the various civil engineering papers at the time of its erection a few years ago. In Fig. 2 are shown two older examples, the one in the rear being a solid masonry arch, while the one in front is an excellent example of the interesting structures found the whole length of the Connecticut valley, built by local "bridgewrights" as they may be called. This one has a lattice frame and a central pier, and is built of timber. Others of these homemade bridges have Howe truss frames, while still others combine the lattice frame with a wooden arch as a reinforcement.

The writer has seen bridges of this kind in which not an ounce of iron was used. All the joints were mortised and tenoned, and fastened with wooden pins. The floor boards were pegged to the beams. The roof boards were pegged to the rafters, and even the hewn shingles were fastened in the same way. Perhaps the longest of these Connecticut River bridges is the one at Springfield, Mass., which many readers of MACHINERY must have seen. Some one has compared them to huge caterpillars crawling across the stream. Anyone who has seen one of them from the distance, with its long, dark and oftentimes crooked body, its stumpy legs resting in the flowing stream, will appreciate the aptness of the comparison.

Figs. 1 and 2. Bellows Falls, Vt., Famous for its Pulp Mills, Bridges and Cream Separators. Two Examples of Bridge Construction: The Homemade Toll Bridge and the Masonry Railway Bridge

The United States Cream Separator

All this is digression, however. The chief thing of interest to the mechanic in Bellows Falls, is the plant of the Vermont Farm Machine Co., whose best known product is the United States separator, used by farmers throughout the country for separating milk into cream and skimmed milk. Through the kindness of the management the writer was permitted to visit the shop and study the various operations which go

* Associate Editor of MACHINERY.

into the making of their product. The work done here proved to be of such interest as to suggest the writing of this article.

Mechanics in the past hundred years have added tremendously to the productiveness of the individual farmer. The mowing machine, the reaper, the threshing machine, the portable engine and other tools have enabled him to cultivate tens and hundreds of acres with better care than he could formerly give to one. The cream separator is a later addition to this list of farm machinery. It has only come into common use

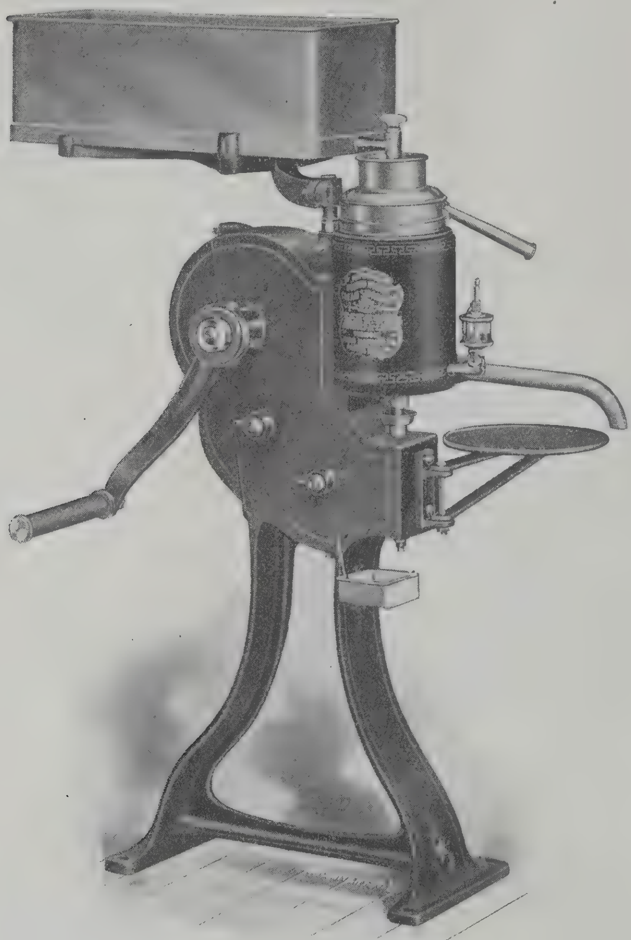

Fig. 3. The United States Cream Separator

in the past twenty years and is still in process of improvement. It enables the farmer to separate the cream immediately after milking, without waiting for the slow and uncertain influence of gravity. The cream is skimmed much cleaner than by the old process, leaving less of it in the milk. The thickness of the cream is under absolute control and is of a better quality, being cleaned from the dirt which is almost sure to find its way into the milk pail. It leaves the skimmed milk fresh and in the best condition to feed to growing cattle.

All these are agricultural features, however. From a mechanical standpoint the separator is interesting because it requires the highest grade of work of any machine used on the farm, being on a par in this particular with the best grade of machine tools. At the same time it has to be so designed and constructed as to be used by people comparatively unskilled, without danger of seriously injuring the mechanism. The important points of durability and easy replacement of parts in case of breakage must also be provided for.

Description of the Separator

The United States separator is shown in elevation and section in Figs. 3 and 4. The milk is emptied into pan *A*, from which it flows through a faucet into the feed cup *B*. A float in this feed cup, entering the faucet, serves to regulate the flow so as to keep an even level in the cup and a consequent even rate of flow through the machine. From *B* the milk passes down into a rapidly revolving bowl *C*, whose construction will be described later. Here the cream is separated from the skimmed milk, the former leaving the machine at *D* and the skimmed milk through spout *E*. The bowl is revolved at some 8,000 or 9,000 revolutions per minute by power, or, as in the case shown, by hand-crank *F*. This drives the train of gearing shown. The last member of this train is the worm-wheel *H*, which, contrary to the usual office of the worm-wheel, drives the steep pitch worm *J*. This worm is cut on the spindle of the bowl which thus receives its rapid motion.

The gears run in a bath of oil which lubricates all the teeth and all the bearings. The easy running of the machine is naturally of extreme importance. The bowl is geared up from the handle in the ratio of about 150 to 1, and with this tremendous increase a slight amount of friction will mean a great difference in the amount of work imposed on the operator. This is one of the points which necessitates very careful work in the construction of the machine. So well are the gearing and journals made and fitted that the weight of the handle will start the bowl in motion.

The bowl and spindle rest on a thrust bearing *K* in the base, formed of a single hardened ball between the hardened stationary and revolving thrust faces. A compressed felt cushion under the lower face supplies elasticity to prevent undue shock. The crank *F* drives shaft *G* by means of a ratchet which permits the bowl to be revolved only in one direction. If it were attempted to drive it in the other direction, there would be a tendency for the bowl to unscrew from the worm and lift out of the frame. The same tendency would be met with if the handle were rigidly fastened to the shaft and it suddenly met with an obstruction, stopping the movement of the train of gears. The ratchet prevents damage

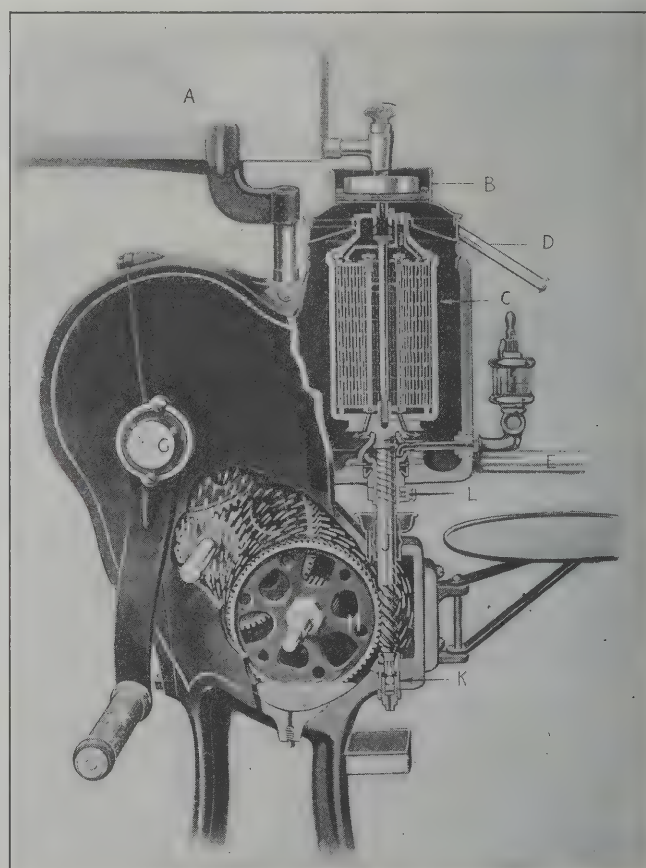

Fig. 4. Mechanism of the United States Separator

from these causes. When the machine is stopped, the bowl and its connected spindle may be easily lifted out for cleaning.

Worm-wheel *H* revolving in the bath of oil, lubricates all the gears and bearings of the train, as well as the worm and step-bearing. The upper neck bearing, *L*, of the spindle, is oiled by a sight-feed lubricator, and is held in a central position by an elastic steel washer, whose compressing effect may be increased or diminished by means of the thumb-screw shown. This adjustment of the spring washer makes provision for steadying the spindle under varying conditions of running balance.

How the Cream is Skimmed from the Milk

In the centrifugal machine the cream is separated from the milk very much faster, but in exactly the same way that it is done in a pan on the "swing-shelf" in the cellar—that is to say, the cream rises to the top because it is lighter, while the milk globules sink to the bottom because they are heavier. The sole function of the separator is to hasten this process by intensifying the force of gravity and by making it a continuous operation, automatically skimming the cream as fast as it rises to the top. The way in which it does this will be understood by reference to Fig. 5, where is shown a section through the bowl. All the parts shown revolve at a high rate of speed with the exception of the stationary nozzle M for the milk.

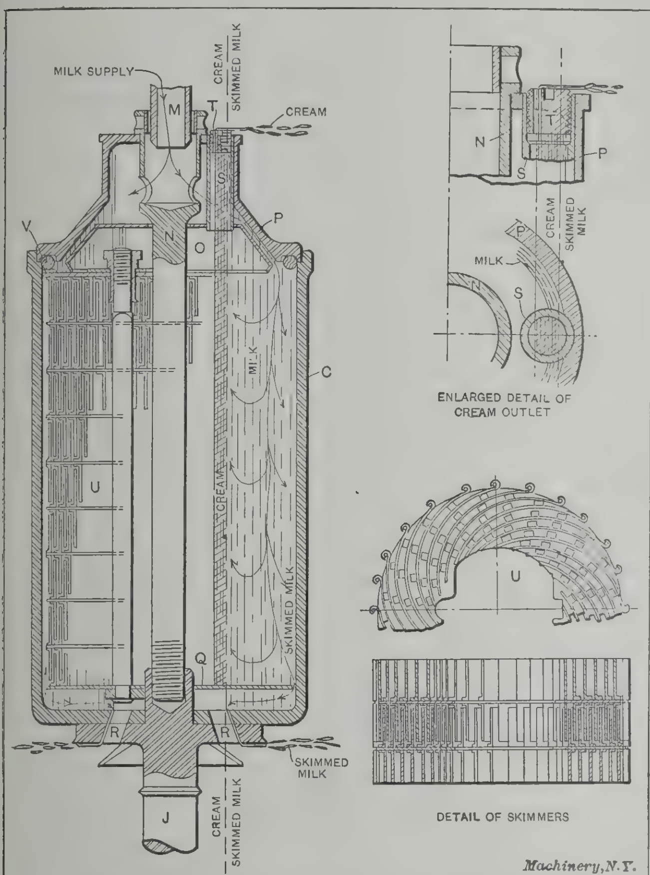

Fig. 5. The Bowl of the Separator, showing the Flow of the Skimmed Milk and Cream

It was said that the separator is a machine for intensifying gravity, thus hastening the rising of the cream. In the bowl shown, which is 3⅜ inches inside diameter, and revolves normally at 9,000 revolutions per minute, the centrifugal force at the outside edge would be

$$\frac{0.000341 \times 1^{11}/_{16} \times 9{,}000^2}{12} = 3{,}880$$

times the forces of gravity—in other words, an ounce located at this point would weigh 3,880 ounces. This result is obtained from the regular formula for centrifugal force.

Now this centrifugal force acts horizontally, and it so far surpasses the vertical force of gravity that the milk stands in a vertical wall against the side of the bowl, forming a hollow cylinder within it as shown at the right side of the bowl section in Fig. 5. A section at the left of the center line is shown with the skimmers in place. These, as will be explained, intensify the action but do not alter the principle.

In Fig. 5 the milk enters through a nozzle M, into the hollow top of the cover bolt N, and out through the side holes into the cover P. From here it passes through the narrow space between the cream chamber O and the cover into the main body of the milk within the bowl. Here, having attained the speed of the bowl, the centrifugal force begins to separate the cream globules from the milk as has been described, the former moving toward the center, and the latter settling close to the shell of the bowl as shown by the separating arrows. The skimmed milk passes downward through the bowl, and around the outside of diaphragm Q, which evidently prevents the escape of cream, since none of the light fat globules will be found at the outlet passage, so near the periphery. From the space below the diaphragm Q, the skimmed milk finds an outlet through the drain holes R, from which it is thrown outward against the casing in which the bowl revolves, running out through tube E in Fig. 4.

It will readily be seen that the distance of holes R from the center determines the inside diameter of the hollow cylinder of milk and cream. The inside diameter above diaphragm Q is smaller than that below, owing to the fact that there is no cream in the lower space. This layer of cream, prevented from escape at the bottom, spreads over the whole inner wall of the cylinder of milk, reaching up through the cream tube S above cream chamber O. The upper end of this tube is closed by cream screw T, which has drilled through it a small eccentric hole. Through this hole the cream is thrown out against the inner wall of the cream pan and its cover, from which it is drained by the cream spout D in Fig. 4.

The purpose of the eccentric hole in the cream screw T is to control the thickness of the cream. By turning this screw the outlet hole may be brought closer to or further away from the center, draining the cream either at the inner stratum, where it is thickest, or at a larger diameter, where it begins to be more diluted with milk. A very slight change of this screw will make a great difference in the consistency of the cream. It is to be understood, of course, that the machine takes practically all the cream, in any case, but it will take as much milk with it as may be required to give the desired consistency. Too thick cream is difficult to handle and unsatisfactory to use.

This whole process of continuous separation will be understood more clearly, perhaps, if Fig. 5 is turned a quarter way round, so that its right side becomes the bottom of the view. If then it be considered that the layers of cream and milk be acted on by gravity, or by a similar force many times as great, it will be seen that the milk flowing in through tube M, through the bowl and under diaphragm Q and out at R, becomes separated from its cream, the latter escaping at tube S.

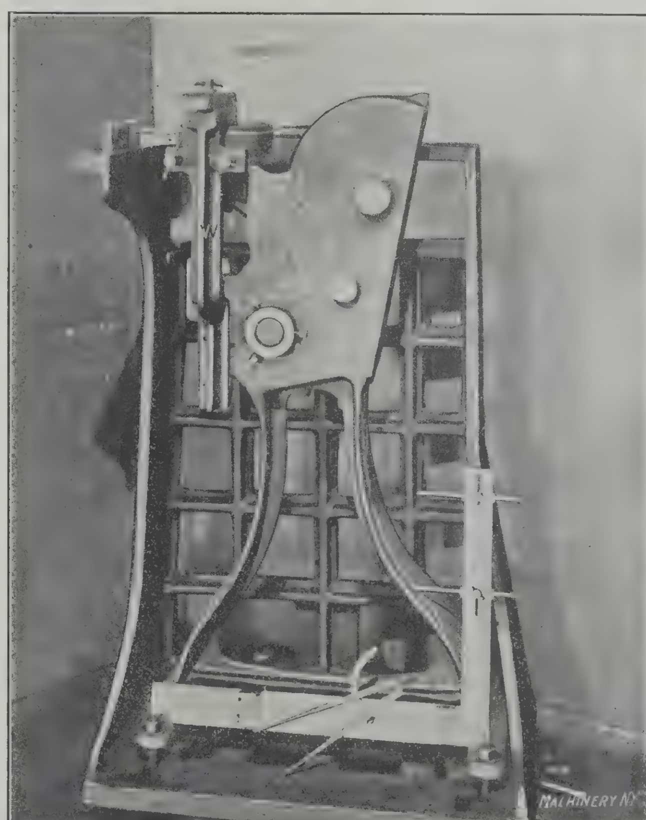

Fig. 6. Lining up the Frame in the Cradle which holds it for the Various Drilling and Finishing Operations

Details of the Bowl Construction

The machine as just described, works very much as the earliest forms did. It is found by experiment, however, that the capacity and clean skimming qualities of the machine can

be greatly improved by filling the space between diaphragm *Q* and cream chamber *O* with a series of guides or "skimmers," *U*. These skimmers serve three purposes. First, they rapidly bring the cream up to the velocity of the bowl; second, they encourage an even, steady flow of milk through the machine without stagnant areas, guiding the milk outward and toward the bottom and the cream inward and toward the top; and third, they so prolong the passage of the milk that it is thoroughly subjected to the action of this separating centrifugal force, so that the cream is more thoroughly removed.

The form of skimmer used in this machine is shown in place in the bowl at the left of Fig. 5, and in detail at the right of the engraving. The whole space between *O* and *Q* is filled with these skimmers, which interlock with each other, as shown, in such a way as to double the number of milk passages, thus increasing the tortuousness of the flow and making the separating action more efficient.

A point in the construction of this bowl which should be noticed is the method of packing the joint between the cover *P* and the bowl *C*. After the skimmers *U* have been placed in the bowl, rubber ring *V* is loosely laid on the upper one

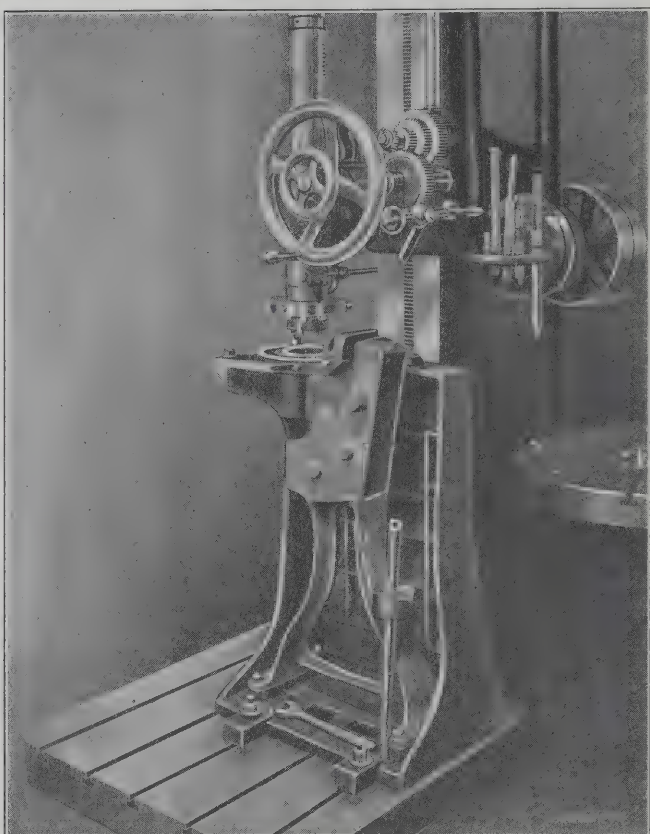

Fig. 7. Machining the Holes and Cylindrical Surfaces about the Axis of the Bowl and Spindle

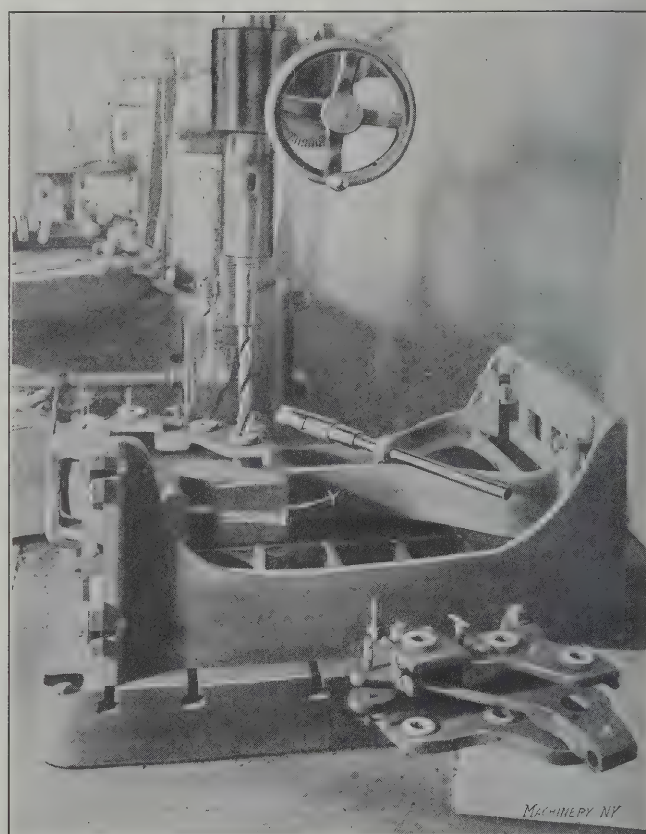

Fig. 8. Drilling, Reaming and Counterboring the Bearings for the Gears

and the cover *P* is placed on top of this, making a metal to metal joint with *C*, and enclosing the ring in the groove shown. Cover bolt *N* is next tightly screwed in place with a spanner wrench, clamping *P* and *C* fast together. This, however, would not make a tight joint against the enormous centrifugal pressure. It remains for the rubber ring *V* to do this, under the influence of the centrifugal force, which, at high speed, causes the ring to hug tightly into the joint, effectively preventing the escape of milk. The higher the speed and the higher the consequent milk pressure, the more effectively will the ring make the joint, thus sealing it against the escape of milk.

Machine Work on the Frame

As intimated, a study of the manufacturing methods employed at this plant gives one a very high regard for the quality of workmanship required for making these separators. It is out of the question to describe all the operations involved, so certain of the more interesting ones have been selected as examples of the remainder of the work.

In Fig. 6 is shown a fixture used for lining up the work. Several of these fixtures (or "cradles" as they are locally called) are provided. A man is continuously engaged in setting the work up in these cradles, so that all the holes and surfaces will machine out. For this purpose he uses various height gages, squares, scratch gages, etc., locating from the finished surfaces of the cradle, using as well the special tool *W*, which shows how to get the proper relation between the spindle and the worm-wheel shaft, with the proper amount of finish around the hubs. One man is thus engaged in laying out the work continuously, while other men perform the drilling operations. While this is a practice which has often been mentioned and universally commended, this is the first time that the writer ever remembers having seen it in actual use.

After thus being lined and set up in the cradle, the frame, still mounted therein, is carried through the various drill-press operations required to finish it. The first of these is the machining of the holes on the axis of the bowl and spindle. This is done on a drill press, as shown in Fig. 7, with various special cutter heads, boring bars, etc., carefully supported and strongly driven to secure proper alignment. The head shown in place on the machine is cleaning out the inside diameter of the bowl casing and finishing the edge or rim. Roughing and finishing tools, both mounted in the same head, follow each other in this operation. Boring bar *X* is provided with the necessary cutters for boring the various surfaces of this axis at one cut, thus giving assurance of their true relation to each other.

In Fig. 8, the frame, still mounted in its cradle, is shown laid on its side and having the shaft holes for the driving gears drilled, reamed and counter-bored. One of the jigs for doing this is shown dismounted from the work at F_1 in front of the cradle. This jig has a central tongue *A*, entering the opening in the side of the frame, and provided with a hole through which passes the arbor *Y*, shown in the frame being machined. This arbor, fitting in the spindle bearing holes in the frame, locates the jig, and with it all the centers of the gearing train, in proper relation with the spindle. The counter-boring bar *Z*, as shown, is used for facing the hubs for the gear shafts, being fed down on them for cutting on the upper side, and drawn upward with the cutter reversed for finishing on the lower side.

After these operations have been completed, together with one or two more of less importance, the frame is thoroughly inspected. The outfit for doing this is shown in Fig. 9. Mounted on the axis of the spindle bearings is shown a sensi-

tive test indicator B_1, attached to the end of arbor A_1. By revolving this arbor, the test indicator tells whether or not the spindle bearing holes are concentric with the finished surfaces at the upper end of the bowl casing. By the use of a series of multiplying levers on the same arbor, it is also possible to use the same indicator for finding out whether the lower spindle bearing holes are in line with the neck bearing at the lower end of the case.

The center distances for the gearing are also carefully tested by means of gages like that shown at C_1. This consists of a strap with a fixed plug at one end and a movable plug at the other. With the fixed plug in one hole, it should be

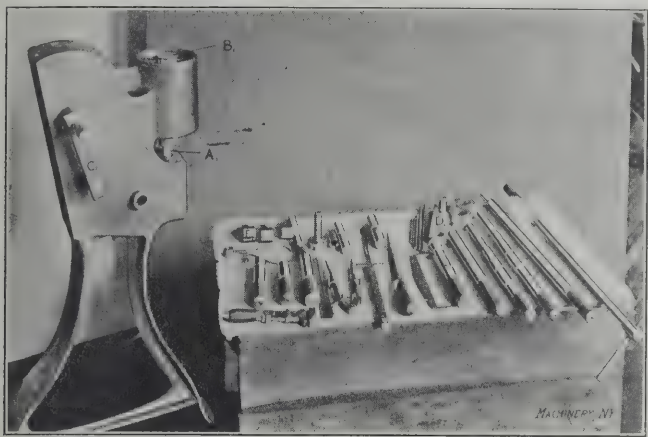

Fig. 9. Tools used by the Inspector in testing the Work done on the Frames

possible to push a standard plug through the other end of the strap into the hole in the casing, if the drilling and reaming has been done properly. This is tested on both sides of the frame, and a similar strap is provided for the second gear reduction, as shown at D_1. Various other plugs, test arbors, etc., are shown. The gage at E_1 is mounted on an arbor passing through the worm-wheel bearings. When swung up and down, it must just barely touch a corresponding arbor placed in the spindle bearings.

Machining the Spindle

The spindles of this machine are made of high carbon steel drop forgings, and are roughed out on the Potter & Johnston automatic chucking machine. It might seem at first as though this would be an impossible job, but the machine has been equipped with special tools which make the operation quite practicable. The spindle (see J, Figs. 4 and 5) is first held

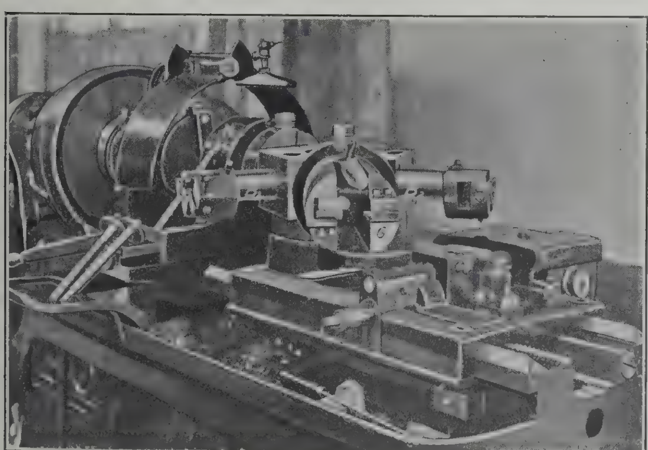

Fig. 10. Rough-turning and Centering the Spindles on the Potter & Johnston Automatic Chucking Machine

in the chuck of the machine by its stem while the flange end is machined. This is a commonplace operation for the automatic. The second operation, shown in Fig. 10, is more unusual. The finished flange of the spindle is held in the chuck with the tail of the work projecting forward. In the turret of the machine are mounted two sets of two tools each, a finished piece of work being delivered at each half revolution of the main cam drum.

The tool at work in the illustration is identical with that shown at G_1, which will perform the same operation on the next piece placed in the chuck. This is a turning tool which commences at the chuck end of the work and feeds outward. The purpose of taking the cut in this way is to permit back resting from the beginning of the cut on the finished diameter left by the first operation, and at the same time to obtain the better results expected in feeding outward on a slender piece, as compared with what would be obtained by feeding against it.

To produce the desired result, the back-rest and cutting tool are mounted on swinging jaws in the heavy holder shown. These jaws are normally held outward by a spring so that they pass over the work freely, when being brought up to the cutting position next to the chuck. When they have arrived at this position, however, both follow rest and blade are closed in onto the work by two special cross-slides (one slide is shown at H_1) which are given the form of one-half bearings, and encircle the finished cylindrical surfaces on the outside of the jaws of the turning tools. The movement of the two cross-slides toward the center, to bring the blade down against the work, is effected by a right- and left-hand cross-slide screw operated by a modification of the regular cross-slide cam mechanism. After the shank of the spindle has thus been rough turned, the second tool, B_1, turns the small diameter at the outer end and centers it.

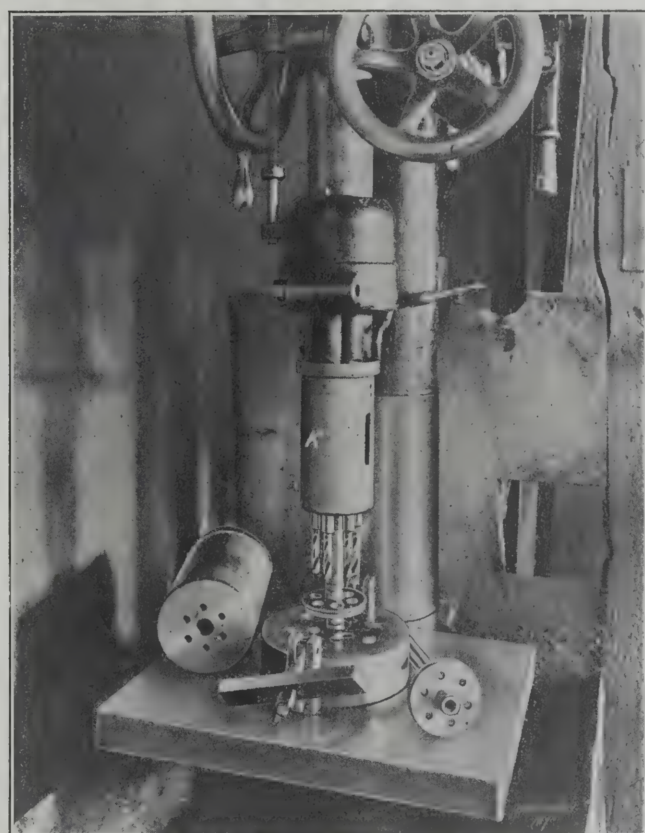

Fig. 11 Multiple Spindle Attachment for Drilling the Rivet Holes in the Spindle Flange and Bowl

The next interesting operation on the spindle is the drilling of the six holes by which it is riveted to the bowl. This is done in a drill press provided with a special multiple spindle attachment, as shown in Fig. 11. The drill spindles are operated by a crank mechanism similar to that used in other devices of this kind, permitting a strong drive at very close center distances. The center of the attachment is hollow, permitting the spindle to pass up through it as shown. The bowls are drilled with the same device, the outside diameter of body K being small enough to enter the bowl. The same attachment is used for counter-sinking the holes in both pieces.

From this point on, the operations on the spindle become merged with those on the bowl, as will be described.

Machining Operations on the Bowl

Cream separator bowls have to be made of first-class material. A four-inch bowl running at 11,000 revolutions per minute (a peripheral speed of two miles per minute) is subject to a very high strain, and when it is considered that there is always a possibility of some husky dare-devil hired man getting hold of the crank and turning it about twice as

fast as it ought to be turned, it will be seen that provision has to be made for emergencies.

The bowls are therefore made from cold or hot-drawn seamless blanks of high carbon steel, and before sending them out in the machines, they are tested at a speed nearly double that at which they will run normally. This means that the centrifugal strain will be four times as great as the normal, since this increases with the square of the velocity.

The cup blanks of the bowls first have a hole drilled in the center of the bottom by means of a simple jig which centers itself accurately. This hole is the one into which the plug end of the spindle projects, as shown in Fig. 5. It is drilled

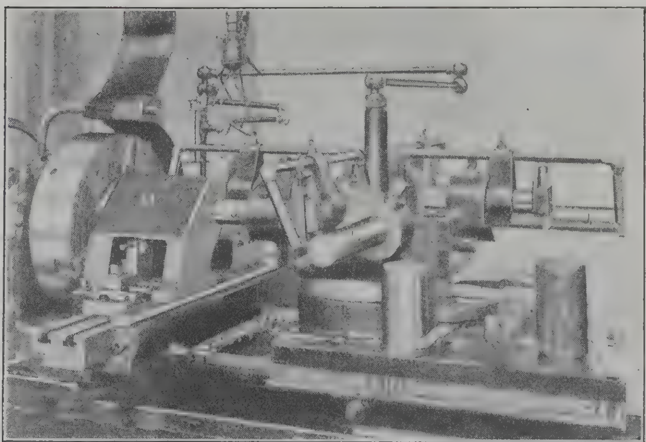

Fig. 12. Turning and Facing the Outside of the Bowl with Supported Tool-holders of Special Construction

first, in order that it may serve to locate and steady the outer end of the blank in the outside rough turning shown in Fig. 12.

This is another Potter & Johnston automatic operation, and is performed with an interesting outfit of tools. The work, of which a rough and a turned sample are shown on the turret slide, is held in a special chuck which grips it on the inside of the rim, while the outer or closed end is steadied by a projecting plug on the end of a pilot solid with the chuck. This leaves the whole of the exterior surface of the bowl free to be turned, without interference with the chuck jaws or other holding devices.

On this machine, as in Fig. 10, two sets of tools are mounted in the turret, so that the machine completes two pieces of work at each revolution of the cam drum. The first operation is the rough turning and facing of the blank. In the

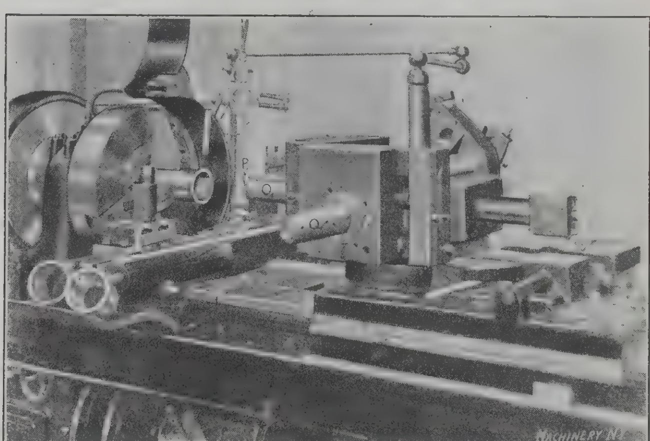

Fig. 13. Boring and Facing the Bottom of the Bowl with Turret Tools manipulated by the Cross-slide

second operation the blank is finish turned and the corner is rounded. The unusual feature of the tool equipment is the provision made for steadying the outside turning tools. These are mounted in long overhanging bars J_1 and L_1, as shown. To give the maximum of stiffness with this long overhang, a bearing M_1 for these tool-bars is immovably bolted to the cross-slide bed. This bearing is bored out to form a seat for the bars and in this seat they are supported during the cut, so that the turret is under no strain except that for feeding the tool ahead. There is no deflection in the turret mechanism of a kind that will limit the rate of feed, or impair the accuracy of the cuts. Oiling arrangements are provided, as shown, to bring a stream to the point of each tool when it comes into operation.

The next automatic operation on the bowl, that of finishing the bore, is shown in Fig. 13. Here also a special tool equipment is provided. The bowl is held by its outside diameter in soft jaws, turned in place, so that the first and second operations run true with each other. An oil pipe passes through the hollow spindle and discharges oil through the hole drilled in the bottom of the bowl, so that the flow outward clears away the chips as fast as they are made in the boring operations. A valve at the nozzle of this oil pipe opens automatically when a piece of work is pressed into the chuck, and closes again when it is removed.

The first cut taken in this operation is that of rough boring and rough turning the end, which is performed by the standard combination tool N_1 at the back side of the turret in the engraving. The second operation is that which is shown about to commence, and consists in rough facing the inside of the bottom. The projecting tool-holder O_1 for this operation is mounted in a cross-slide on the face of the turret, and is normally pressed back by a stout coiled spring. The turret is fed up until the blade has reached the proper depth, when the rear cross-slide comes up, carrying a roller abutment P_1 which feeds the turret cross-slide tool forward on its sliding base, facing the bottom of the cut from the center in toward the side.

The third tool Q_1 and its cut are like the second, being first a finish facing operation performed in the same identical

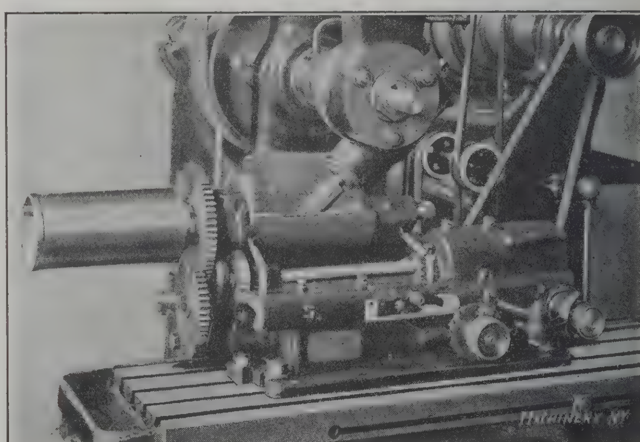

Fig. 14. Milling the Spindle Driving Worm in a Completely Automatic Attachment for the Plain Milling Machine

way. At the end of this operation, however, the cross-slide abutment remains stationary, while the turret is fed backward with the back side of the tool bar held up to its work by the roller on the abutment. By this means the same blade is made to face the bottom of the hole and finish the bore.

The fourth and last cut is taken with the inserted blade reaming or counterboring tool R_1, which finishes the outer edge of the bowl very accurately to size. After this operation the bowl is drilled in the attachment shown in Fig. 11, and the bowl and spindle are riveted together.

Reasons for the Use of Automatic Machines

It struck the writer that the tool equipment illustrated in Figs. 10, 12 and 13, together with others of a similar nature not here described, make up the most ingenious and highly developed equipment he has ever seen used on an automatic turret machine. All of those illustrated, it will be seen, adapt the machine for taking long cuts with rapidity and precision, thus bringing it more closely into competition than usual with the engine lathe and with certain forms of highly specialized hand-operated lathes for the same work. This brings up the question of the field of the automatic machine—a question which is never ending, because of the ever-changing conditions under which it is decided in different shops.

A natural thought in looking at Figs. 10, 12 and 13 is that the tool designer has taken considerable pains to adapt these automatic machines to work for which they are not usually employed. But that this process of adaptation has been well done, there can be little doubt to any one who watches these

machines at work. They require very little attention, and produce work up to the high standard required of them.

Various other advantages are urged for this type. That of low labor cost is taken for granted in successful automatic machinery. Besides this, a less expensive grade of labor may be employed, and men may be more easily changed from one job to another. On hand-operated machines working at a high efficiency, there is a tendency for the workman to specialize, and his production, when he is broken in on a new job, suffers more than does that of the automatic machine and its operator under the same conditions. The use of the automatic thus gives a greater flexibility to the organization.

One experienced man is employed to look after the tooling and setting up of the twenty odd turret machines used here. By giving proper care to the cutting edges, the automatic machines under his control can be depended on to produce work of a high degree of uniformity in dimensions, hour after hour, and day after day. Neither he nor the men under him are rushed in getting out the maximum production of the machines—the duties of the operatives being, ordinarily, simply that of putting in and taking out the work.

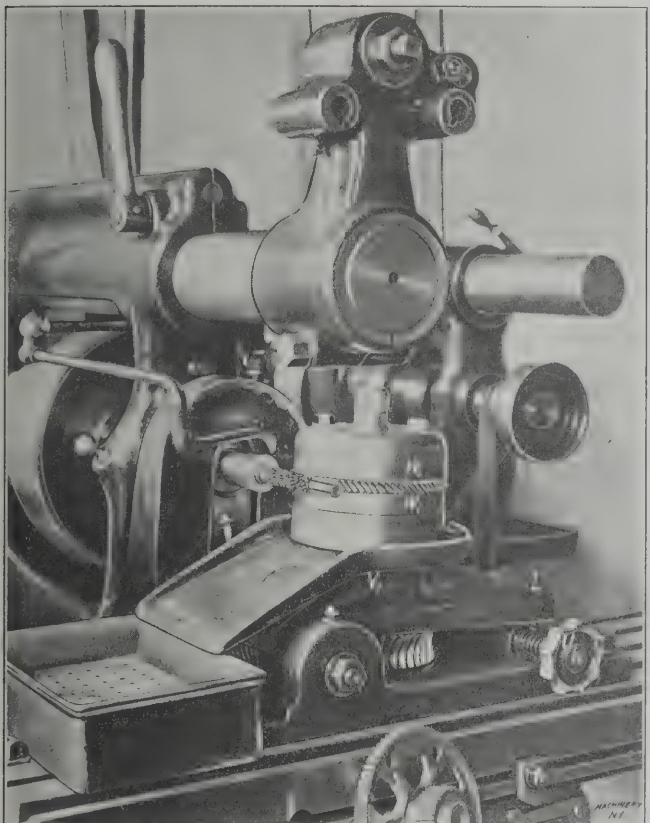

Fig. 15. Hobbing Attachment for Cutting the Teeth in the Driving Worm-wheels; Overhanging Arm turned back to show Hob

Against these advantages must be weighed the advantages of hand machines in other respects, such, for instance, as the lower capital investment, the (sometimes) higher output per machine, the more constant personal supervision, and the less elaboration required in the tool equipment. In striking the balance between these advantages and disadvantages, the management of this shop feels that it has reached the right conclusion for conditions as they occur in the work here.

Finishing Operations on the Bowl and Spindle

After being assembled, the bowl and spindle are finish turned on the outside over the whole length in the engine lathe, the work being held on an internal expanding chuck, which accurately centers and holds the bowl by its interior surface. This gives assurance that the outside of the bowl and the whole length of the spindle will be turned true with the inside of the bowl. The neck bearing, next to the flange of the spindle, is, in this operation, turned and filed to its finished size, which is required to be accurate within 0.0002 inch. Stock is left for grinding at the lower or step bearing end of the spindle. The reason for finishing the neck bearing at this time will be understood in connection with the operation shown later in Fig. 16.

The bowl and spindle being thus finish turned all over, the work is next taken to the milling machine department to have the worm thread cut on the spindle. This is done in the special Brown & Sharpe milling attachment shown in Fig. 14. This attachment is entirely automatic. The main table of the milling machine is locked in position at the proper point to center the cutter with the work and set it to proper depth. The work is mounted on a supplementary slide S_1 in the fix-

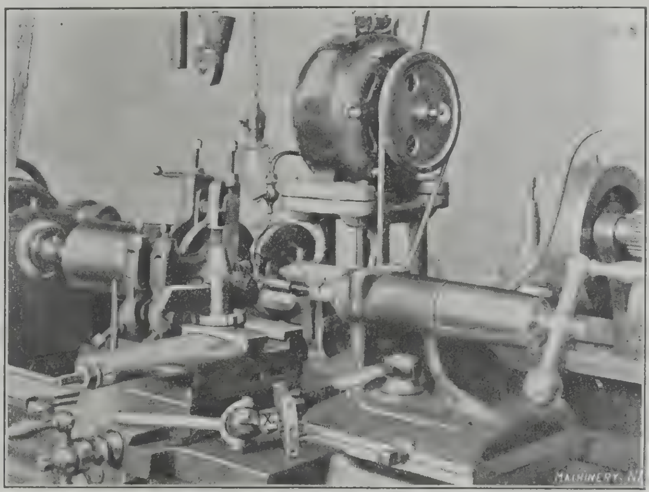

Fig. 16. Finish Turning and Grinding the Bowl Spindles

ture, whose feed-screw is geared (to give the desired lead of helix) with the quill chuck, which grasps the spindle by the neck bearing.

Properly set up in this way, the mechanism of the device feeds the spindle forward, cutting one thread. When this thread has been cut the proper length, an automatic stop throws in operation mechanism which first rocks the spindle, carrying head T_1 back away from the cutter, returning the slide to its initial position, then indexes the spindle for the cutting of the second thread, and lastly sinks the cutter in to depth again. Besides this, the device is "full automatic" to the extent that its feed movements are arrested when the required number of threads have been cut. The mechanism is connected to the regular telescoping feed shaft of the miller. The cutter is mounted on the regular vertical and angular milling attachment, set to agree with the desired helix angle of the thread.

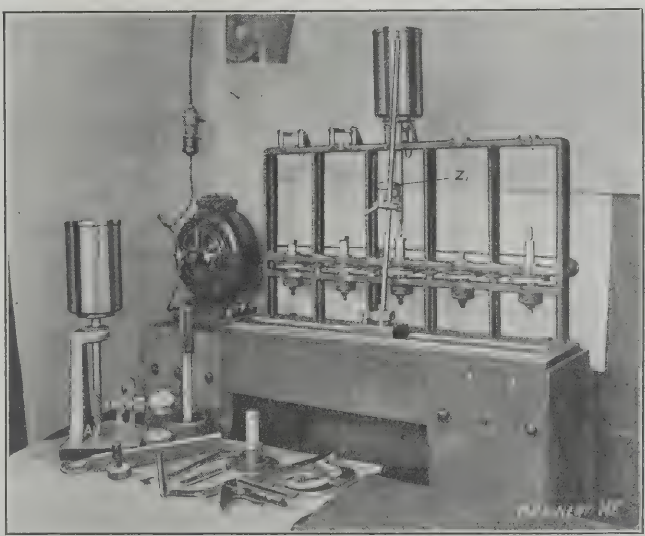

Fig. 17. Testing Outfit for Inspecting the Bowls and Spindles

The corresponding operation for hobbing the worm-wheel may be mentioned here though it is a little out of the strict order of operations we have been following. In this attachment (see Fig. 15) the worm-wheel is mounted on a vertical work-spindle on a special fixture in the milling machine, the table of which has been clamped in the desired position as in the previous case. This work-spindle is driven by worm-gearing and a train of spur-gearing connecting it with the spindle in the proper ratio.

The feeding of the hob in to depth is done by hand through the operation of knob U_1 shown at the base of the machine.

This, through suitable connections, rocks the work-spindle base V_1 about the axis of the work-driving worm, thus moving the work in toward or away from the hob as may be desired. The work is only located by the work-spindle, being held by special face-plate clamps W_1, which clasp the rim firmly, close to the cutting point. This prevents the distortion which would otherwise be inevitable in so small and light a worm-wheel.

In Fig. 16 is shown a lathe rigged up for the finishing operation on the worm-spindle. The work is held in two back-rests, one of which bears on the neck bearing, which was filed to size in the finish turning operation before described; the other back-rest bears on the spindle just above the worm bearing. As these surfaces were finish turned "in the air," while the bowl was held accurately by its interior bore, every assurance is given that the bowl is so held as to run true; and as the spindle was chucked by these same surfaces in the worm cutting operation, it may be assumed also that this will run true. The bowl is driven from the spindle of the lathe by a universal joint driver X_1, which is shown lying on the top of the carriage in Fig. 16. The four pins in its face bear on the bottom of the bowl and take the thrust of the cutting. The copper friction pieces at the sides are expanded by the taper screw shown so as to grip the sides of the bowl and drive it firmly without distorting it.

The lathe is provided with a turning tool for taking finishing cuts over the step-bearing, and with a motor-driven grinding attachment, as shown, for finish grinding the step-bearing. A suitable tail-stock holder is furnished for carrying drills, bits, etc., for finishing the hole in which the hardened step is inserted. This, with various minor operations, completes the work on the bowl and spindle.

Inspecting and Balancing the Bowls

The outfit shown in Fig. 17 is used by the inspector for testing the work on the bowl and spindle. The frame shown at the back contains a series of motor-driven spindles, each provided with a true running socket for receiving various designs of separator spindles and bowls. One of these is shown in place. The dial test indicator Z_1 is mounted on an adjustable swiveling and sliding post, so that the truth of any or all of the revolving surfaces, from one end to the other, may be tested by it.

The fixture shown at A_2 is for testing the truth of the worm cutting. The spindle is inserted in bushings in the fixture, which bear on the journals on which the spindle is to revolve in the completed machine. The dial indicator is mounted on a plunger which may be moved in to a positive stop, and is in turn carried by a standard on the base of this fixture. A forked point is provided for the indicator plunger, which straddles the worm thread and bears on the pitch line. By bringing this plunger over each worm thread in turn, the pitch radius at each thread is indicated; the truth of the tops of the threads is a matter of comparatively little importance; the question is, "Do the acting surfaces of the threads run out?" That question the indicator solves accurately and quickly.

The various other tools shown, consisting of depth gages, internal and external micrometers, snap gages, etc., are used in obvious ways to test the accuracy of the various diameters and lengths of the work. All this accuracy in the bowl and spindle is required to produce the proper balance for quiet running at high speeds. The more accurately the machining operations are performed, the less time will have to be spent on the costly and tedious work of compensating for errors in balance.

The balancing of the bowls is done with all the rotating parts assembled and (in this firm's practice) with the bowl full of liquid. This latter is an important improvement in this operation, as the distribution of weights in the bowl must inevitably be somewhat different when it is full from what it is when empty. It makes the balancing operating more costly but better results are obtained.

This job of balancing separator bowls is a peculiar one, being a trade in itself. So far as we know but one article descriptive of it has ever been written, and that was published in MACHINERY.* It is said that the men have to learn the business for themselves, it being almost impossible to teach it, and that different men work in different ways. Some men cannot learn to do it at all. What is reputed to be a fair statement of the case was made by a German in this shop, who tried for six months to get on to the job and finally failed. "First, I put in some solder on the top and then on the bottom, and then I put in some more, and then I fill her up with solder, and then I take it all out, and she run better than she did before." All of which is rather discouraging for the editor, who likes to set things down definitely in black and white.

This concludes the list of operations selected for this article, to show the character of work required and obtained in the building of cream separators. On hearing the name "Vermont Farm Machine Co.," a vision naturally arises in the mechanic's mind of a blacksmith shop sort of an establishment, where plows, shovels, harrows, cultivators and other tools of that kind are made. It is to be hoped that this article will dispel this illusion, and that the name will henceforth stand in the reader's mind for machine shop work of a very high grade indeed.

* See "Cream Separator Bowl Balancing" in the September, 1907, issue of MACHINERY.

* * *

DON'TS FOR PATTERN-MAKERS

H. E. WOOD*

Don't use watery glue.

Don't glue battens on a pattern.

Don't be afraid to ask for information.

Don't set a plane flat down on your bench.

Don't try to glue up a piece of wet lumber.

Don't forget to put draft on your patterns.

Don't use green or wet lumber; it is no good.

Don't forget to make allowance for your finish.

Don't try to trim work without a very keen-edge tool.

Don't nail a standard pattern unless absolutely unavoidable.

Don't forget to mark your loose pieces with the pattern number.

Don't sandpaper your work until you are all through with trimming.

Don't start to build a pattern before you understand the drawing.

Don't put on more than one coat of shellac without sandpapering it.

Don't forget to study other men's work, and profit by their experience.

Don't be in too much of a rush when you are working on a complicated job.

Don't put any unnecessary work on a pattern that is to be used only once.

Don't waste leather fillets in places where wooden ones can be used just as well.

Don't hold a hand lathe tool at right angles to the center line of a revolving piece.

Don't try to scrape a piece of work in a lathe, but hold the chisel so as to cut it.

Don't try to drive a nail through a piece of hardwood without first boring a pilot hole.

Don't make a pattern to suit your own liking, but remember that it goes to the foundry.

Don't make a coreprint so that it is impossible for the molder to get it out of the sand.

Don't put a leather fillet around a small curve without wetting it in luke-warm water.

* * *

An iron and steel scrap heap of enormous dimensions was shown in an illustration in a recent issue of the *Iron Trade Review*. The scrap heap is one of the relics of the great conflagration in San Francisco in April, 1906, the principal accumulations being those in the yards of the Great Western Iron and Steel Co., where four scrap heaps 100 feet square and 40 feet high were recently stored. All the scrap was cut in equal lengths of 18 inches and piled in one solid mass, with the sides practically as smooth and solid as a brick wall. Only one scrap heap now remains, the other three having been drawn upon as the material was needed for the furnaces.

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DIE-BEDS OR BOLSTERS FOR PRESSES

DORBRO

The subject of die-beds or bolsters is one of considerable importance, and is deserving of greater attention than it often receives in the shop or designing room. It has been the experience of the writer that many of the troubles encountered in the use of press tools are due to this feature being badly designed or poorly constructed. Many a fine die has been ruined because it has not been properly secured in the die-bed and consequently has shifted while in operation; or because the holes in the die-bed through which the blanks or punchings are supposed to pass have not been made large enough to allow them to pass through freely. As a consequence the blanks get jammed in the die-bed and pile up into the die itself and are compressed by the pounding of the punch, until the punch or die breaks from the strain. The principal functions of a die-bed are: first, that of supplying an adequate support for the die, and a holder to hold the die in its proper position to be engaged by the punch; and, second, to furnish a means of attachment to the press. Two of these principal points to be considered therefore in the design and construction of a die-bed are first, the method of securing the die, and second, the method of securing the die-bed to the press. Due consideration, of course, should also be given to proportion and strength.

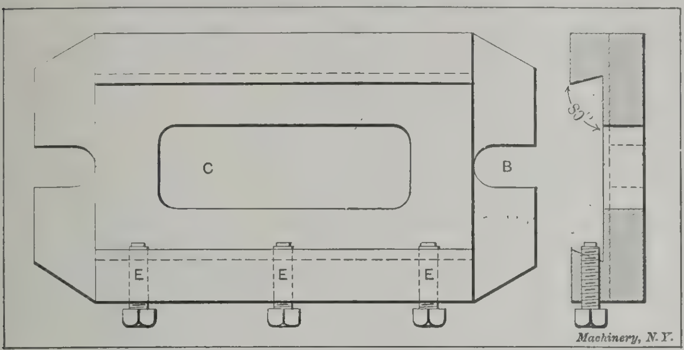


Fig. 1. Die-bed of the Style commonly used in Jobbing Shops

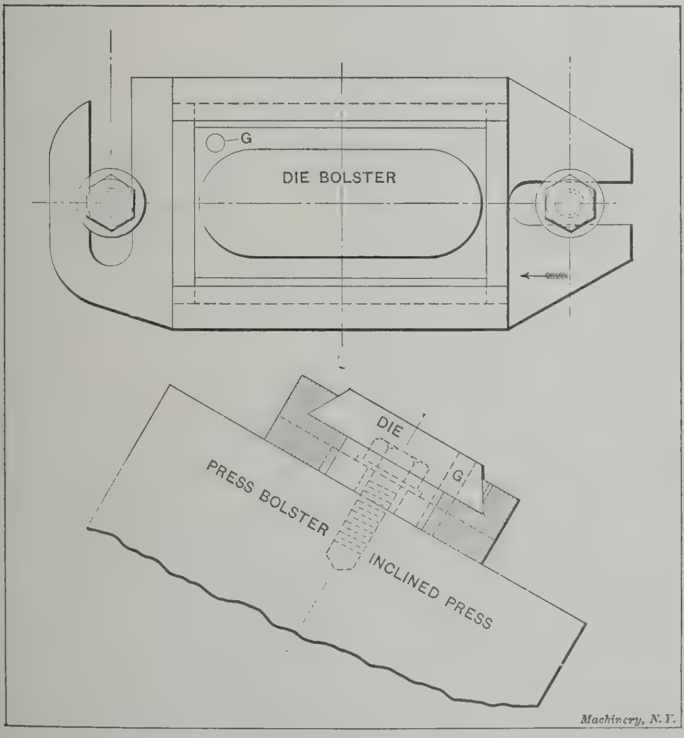


Fig. 2. Die-bed adapted to Inclined Presses

In Fig. 1 we have an illustration of a die-bed of the type generally found in the jobbing shop. The dovetail method of holding the die, with set-screws E to lock it in proper position, is employed. It is fitted with a flange J on each end with slots B to receive the clamping bolts which pass through them into the press bolster. In the center is a rectangular cored hole to let the punchings pass through. This style of die-bed is cheap and convenient for use where several dies are to be used in one die-bed. The dies can be easily slid into place and fastened by means of the set-screws, and are easily removed when another die is to be used. This bed has the following disadvantages: first, that of being held by set-screws which have always a tendency to jar loose in punch press work, and second, the cored hole C being necessarily made large to accommodate various shapes of blanks weakens the bed and gives less support to each of the dies. It is always better, if possible, to have a separate die-bed for each die.

In Fig. 2 we have a bed for use on an inclined press. In this bolster the dovetail method of holding the die is used, but without the use of set-screws. The dovetailed opening to receive the die is slightly tapered and the die is driven into place with a copper mallet, and is then made doubly secure by the insertion of a dowel which is driven through the die into the die-bed. The dowel is shown at G. The method of clamping this bed to the press bolster is different from that shown in Fig. 1 in that the bolt slot in one flange runs at right angles to that in the opposite flange. By having the slots in this position the die-bed may be attached or removed without the necessity of taking out the bolts, thus not only saving a great deal of time and trouble in setting the tools but

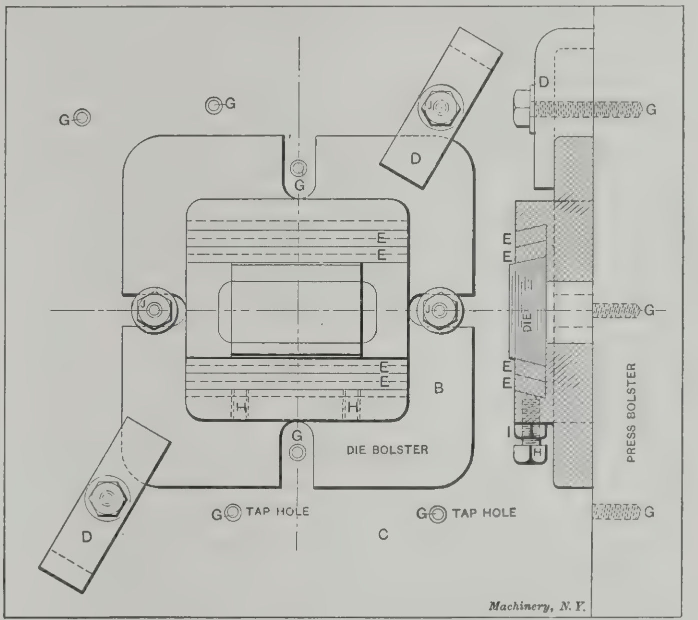


Fig. 3. Improved Form of Die-bed for General Utility

also preventing the bolt holes from getting filled with scrap or dirt and the bolts from getting lost. This is an excellent die-bed for blanking and piercing work.

An improved type of die-bed for general utility is shown in Fig. 3. In this bed the dovetail method of holding the die is used. In the illustration it will be noticed that there are four parallel pieces or gibs E placed along the sides of the die. The object of this is to provide for dies of various sizes. When a larger die is to be used one or more of these gibs may be taken out. This bolster, in addition to four bolt slots, has a flange B all around it so that it may be clamped in any position. The set-screws H which hold the die in place should be provided with a lock-nut as shown at I to lessen the chances of jarring loose. The great advantage of having a flange all around the bolster will be apparent when it becomes necessary to swing the die-bed around enough to bring the bolt slots out of line with the tap holes in the press bolster. In a case of this kind the die-bed with a flange all around it may be clamped by means of clamps as shown at D, using the tap holes G located at different places in the press bolster C.

In Fig. 4 we have another die-bed of the dovetail and side set-screw variety, but with the additional feature of end-thrust set-screws. This end-thrust arrangement is an original and novel feature. In order to obtain this additional means of holding the die securely, two square grooves B are cut in each end of the die-bed at right angles to the opening for the die. Into these grooves a plate C is fitted in which is a set-screw in such position as to come in contact with the end of the die. With one of these plates at each end, and the set-

screws screwed tightly against the ends of the die, there is less likelihood of its shifting while in operation. When short dies for simple blanking or piercing are used the end-thrust plates may be used in the inner grooves as shown in Fig. 4, and if it be desired to use a long die such as is used for progressive work where there is one or more piercing operations before the work reaches the blanking punch, the plates with the set-screws may be placed in the grooves further from the center, and thus allow for the increased length of die. When the set-screws are used in these outer grooves, the heads of the screws will come directly over the slots in the flanges where the clamping bolts should be placed; for this reason the bed should be provided with two extra slotted flanges, as shown in the illustration, to be used when necessary.

In Fig. 5 we have an illustration of a die-bed for sectional forming or blanking dies or for split dies. This bed is provided with a square receptacle to receive the dies, and with two set-screws on each side to hold the dies in place. The square forming die shown is made in four sections *B* which are held tightly against each other by means of the set-screws *C*, and are held from lifting up by screws through the bot-

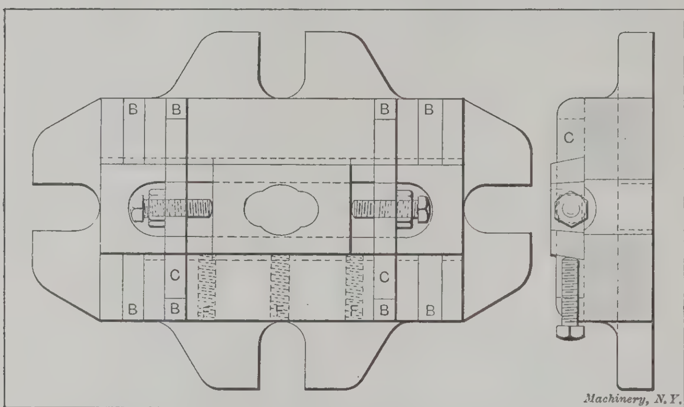


Fig. 4. Die-bed of the Dovetailed and Side Set-screw Type, also secured by End-thrust Set-screws

tom of the die-bed—one in each section of the die. The square recess is cast in the bed so that in preparing the bed for use it is only necessary to plane off the bottom and top of the flanges and mill the bottom of the recess, and drill and tap for the set-screws. The sides of the recess need not be machined as the dies have no bearing on them.

A very simple type of die-bed for bending and forming dies is shown in Fig. 6. It is simply a vise similar in some respects to a milling vise, but having two set-screws to take the place of the movable jaw. The die is simply set in the bed and clamped against the solid jaw by means of the set-screws. This type of bolster is intended for use only on dies that do not require a "push up," but where the bending or forming operations are done on a solid surface. In order to

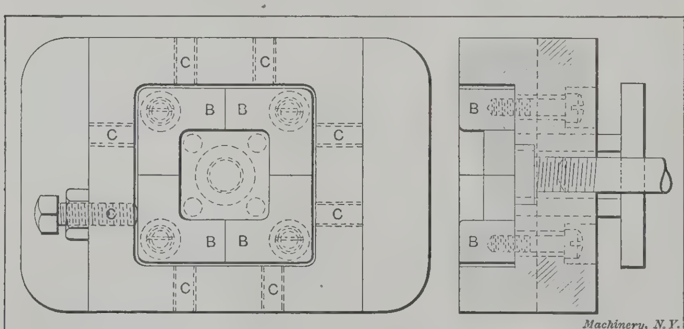


Fig. 5. Die-bed for Sectional Forming or Split Dies

obtain the best results from this die-bed, the complete outfit of punch holder, punch and die of the type shown in the sketch should be used. The punch holder and punch are made just the same as the die and die-bed. They are kept in alignment when in operation by the two guide pins *E* which are secured in the punch and which enter the die at every stroke of the press, making it practically impossible for the tools to shift while in operation. If it be desired to change the tools it is not necessary to disturb the punch holder or die-bed. They may be left in the press, and by simply loosening the set-screws in the die-bed and punch holder, the punch and die held together by the guide pins may be taken out and set aside and another set slipped into their places. There is an infinite variety of light bending and forming operations that can be done advantageously and cheaply with this outfit.

Fig. 7 represents a bolster for combination dies for round drawing work. This bolster requires but little explanation. It is circular in shape with two steps or extensions, two bolt

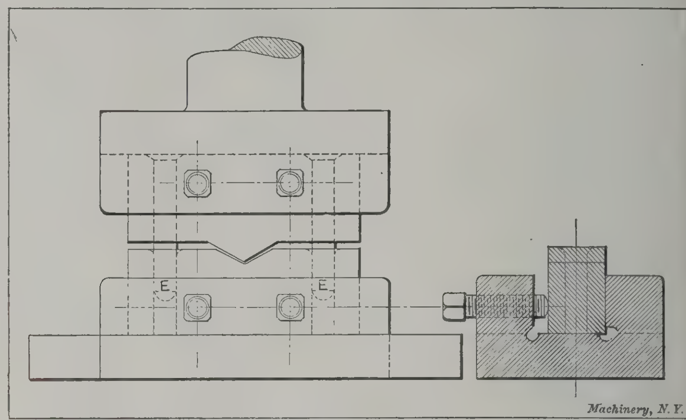


Fig. 6. Simple Form of Die Holder adapted to Bending Die

slots and a flange all around it to allow it to be clamped at any convenient place. When the combination dies are turned in the lathe the bottom die is counterbored to be a driving fit on the extension *G*, and is held down by screws that pass through the bed at *E* into the die.

* * *

STORAGE AREA RESTRICTION PLAN FOR MACHINE SHOPS

In shops where a large volume of heavy work is turned out on a comparatively limited floor space, there is a constant tendency to store work (rough, finished, and in course of machining) in areas which encroach on the passageways re-

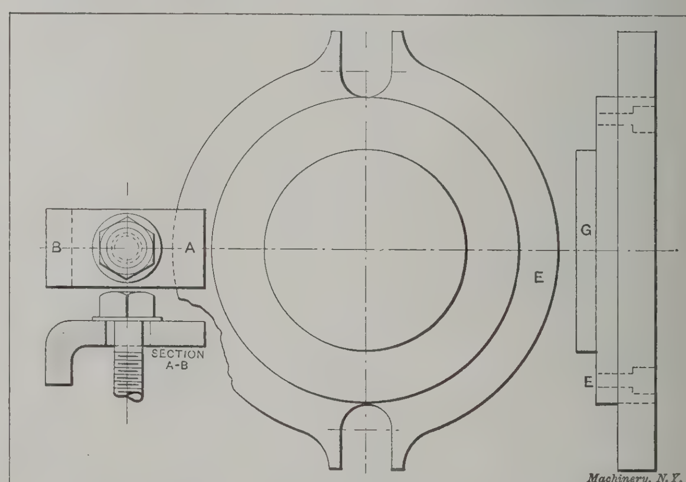


Fig. 7. Die-bed or Bolster for Round Drawn Work

quired for the movement of the parts through the shop. In the works of the Westinghouse Machine Co., at East Pittsburg, Pa., this tendency is restrained in a very simple way. The areas available for storage are marked off on the floor with lines of white paint. These areas provide for grouping work around each machine, and for using all available vacant spaces as well; but they are carefully laid out to avoid checking the freedom of movement of work and workmen. A single glance of the eye reveals any infraction of the regulations, as the lines are kept freshly painted. By this means the management has avoided that state of chronic congestion which is so fatal to economical production.

* * *

Following the example of the English Patents Act of 1907, the Australian Commonwealth has passed an amendment to the Australian patent act, which makes the manufacture of all articles patented in the Commonwealth compulsory under penalty of forfeiture of rights.

A FORMED TOOL PROBLEM

H. V. PURMAN*

One day the man who was making the formed tools came to me and said: "I want to make this master-tool with an angle of 15 degrees from the center line and with a clearance on the front of 25 degrees; and in addition to that I want to give it a side clearance of 2 degrees to keep it from dragging. I will set it in the planer vise tipped forward at an angle of 25 degrees and swing the vise around 2 degrees.

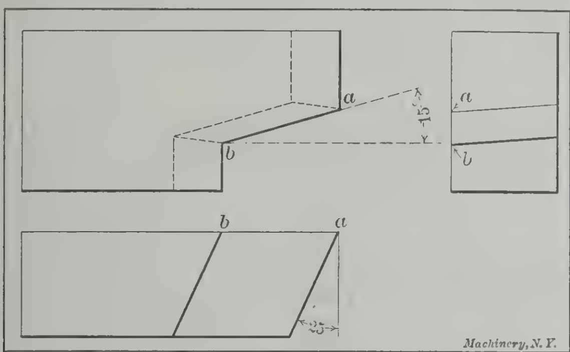


Fig. 1

Then to what angle must I set over my planer head to plane the tool so that it will measure 15 degrees on the cutting face?"

This is a sensible, practical question, but how many of our technical school men, either in or just out of college, could answer it? In the following is given a solution of this problem, worked out by the writer.

The master-tool is shown in three views in Fig. 1, where the plan, or face view, shows the side angle, 15 degrees, and the side elevation shows the front clearance of 25 degrees. In Fig. 2 the tool is shown as set in the planer vise ready for planing. In the top view the 2-degree angle is clearly shown, exaggerated, the vise and pieces being swiveled around as indicated by the divergence of the edge of the tool to be made from the line of the cross-rail. The side view shows the piece as seen from the side of the platen, looking squarely across, and the face view shows it as looked at in line with the platen travel, when the surface in which the points *a*, *d*, *c* and *b* are located appears as a line. This line is at the real angle of the tool-head from the vertical, and its angle with the vertical must be found.

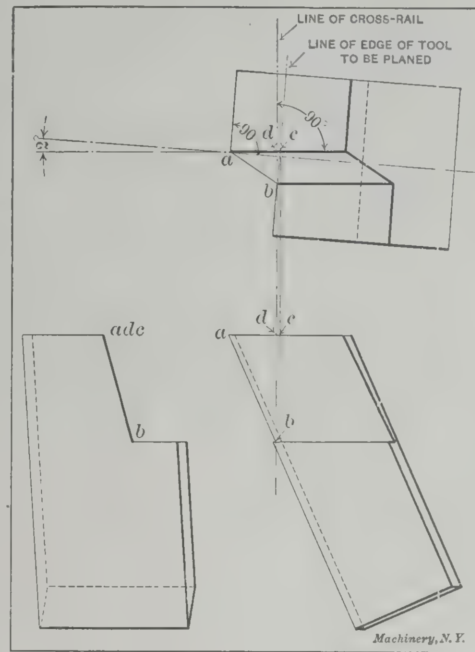
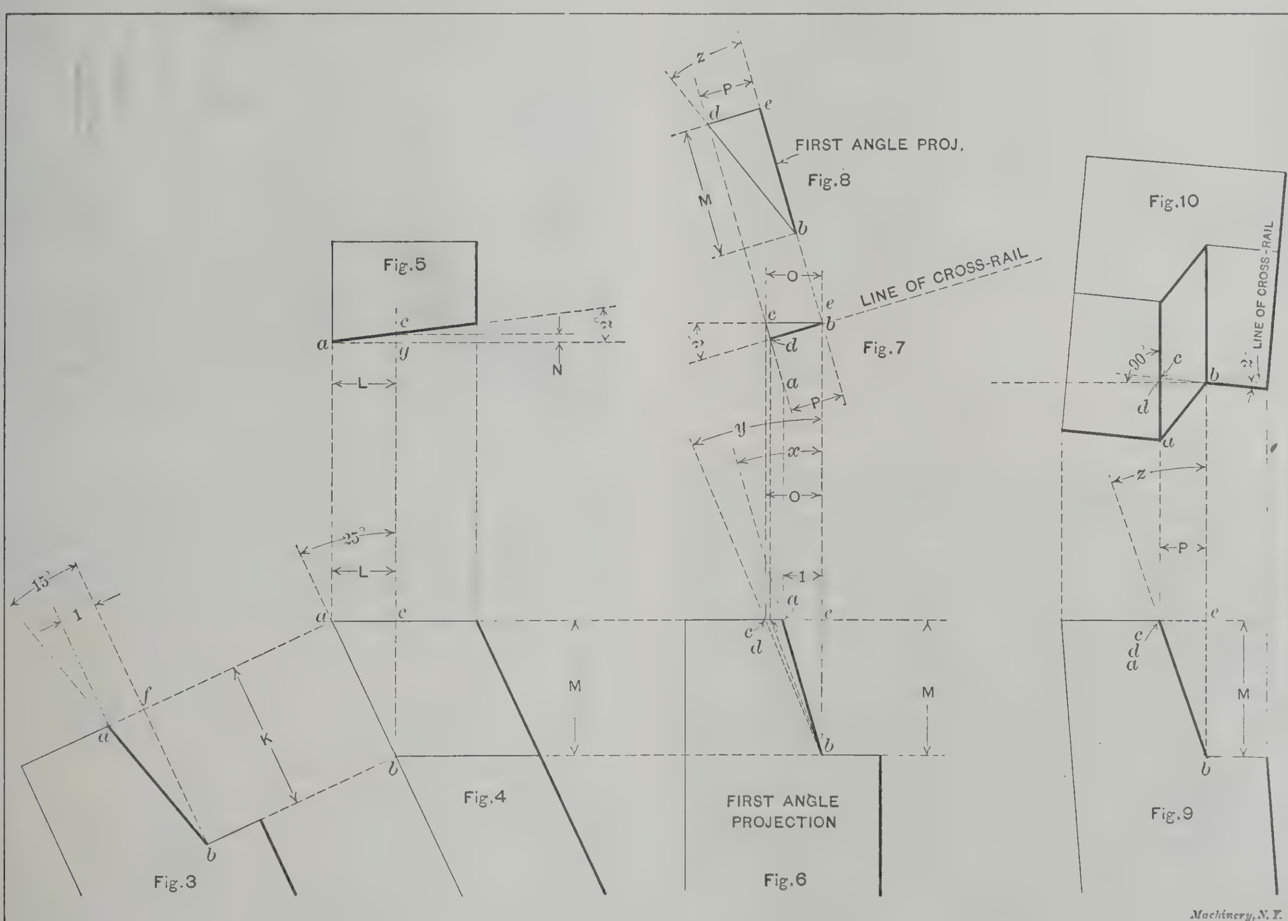


Fig. 2

To do this we will use a series of diagrams, representing the essential lines of the tool in various positions. Fig. 3 shows the plan of the tool, Fig. 4 its side elevation, and Fig. 5 the top of the tool in the horizontal plane when the tool is tipped forward. Fig. 6 shows the face of the tool merely inclined but not swiveled; Fig. 7 shows a portion of the edge receding from the corner, when swiveled, and Fig. 8 shows a line in the surface of the oblique side of the tool, each of these last two diagrams showing also the lines needed to calculate the angles and distances involved. Figs. 9 and 10 represent the surfaces, front and top, of the tool inclined and swiveled, as in Fig. 2.



Figs. 3 to 10

Referring again to Fig. 2, it must be noted that point *c* is in the vertical plane containing point *b* and the edge terminating in *b*, while point *d* is in the vertical plane contain-

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ing point b and parallel with the cross-rail, while a, d and c are all in the edge of the tool receding from a, hence in a straight line, as clearly shown in the side elevation; they therefore appear as a single point adc in the front elevation. Now ab is the cutting edge of the tool, and db is the line of feed of the planer tool, since the work is swiveled.

Throughout the views and diagrams the same points are designated by the same letters, but in the diagrams additional letters (capitals) are used to denote dimensions, for ease in calculation, and for clearness and accuracy, since the points appear in projection at different distances in different views.

Let the distance af, Fig. 3, or the actual amount the edge of the tool slants to the left, or the short side of the 15-degree triangle, be considered as unity, for simplicity, then

$$\frac{K}{1} = \cot 15°, \text{ or } K = \cot 15°,$$

$$L = K \sin 25° = \cot 15° \sin 25°,$$

$$M = K \cos 25° = \cot 15° \cos 25°,$$

$$\text{and } \frac{M}{1} = \cot x, \text{ or } M = \cot x.$$

Angle x is the apparent or projected angle of the edge, or the angle of tool travel were the shoe not swiveled; but because of the swiveling, the tool travels over farther in rising a given height, that is, takes off more metal, and gives more clearance, and we must find what this added distance is. It is the distance cg, Fig. 5, equal to ca, Fig. 6, where g is the point directly behind a and on the line ce.

Let $cg = N$, then

$$\frac{N}{L} = \tan 2°; \; N = L \tan 2° = \cot 15° \sin 25° \tan 2°.$$

$$\text{Now } O \; (= ce, \text{ Fig. 6}) = 1 + N, \text{ and } \frac{O}{M} = \tan y.$$

Angle y is the apparent or projected angle of tool travel when the 2 deg. clearance is given, and we look squarely at the face of the tool. But this is not the actual angle, which must be seen in the line of platen travel, as in Figs. 2, 8 and 9. The actual side motion, then, of the tool, in rising a vertical height eb or M, is $de = P$, Figs. 7, 8 and 9.

$$\frac{P}{O} = \cos 2°; \; P = O \cos 2° = (1 + N) \cos 2°$$

$$= (1 + \cot 15° \sin 25° \tan 2°) \cos 2°.$$

In Fig. 8, $\frac{P}{M} = \tan z$. This triangle appears in Fig. 9 also, and angle z is the actual angle sought. Then

$$\tan z = \frac{P}{M} = \frac{(1 + \cot 15° \sin 25° \tan 2°) \cos 2°}{\cot 15° \cos 25°}$$

[The formula above can be generalized and somewhat modified as follows: If w = angle on face of tool (here 15°),
v = clearance angle in front (here 25°),
y = side clearance angle (here 2°),

$$\text{then } \tan z = \frac{(1 + \cot w \sin v \tan y) \cos y}{\cot w \cos v}.$$

But $\tan y = \frac{\sin y}{\cos y}$; substituting this in the formula and reducing, we have

$$\tan z = \frac{\cos y + \cot w \sin v \sin y}{\cot w \cos v}.$$

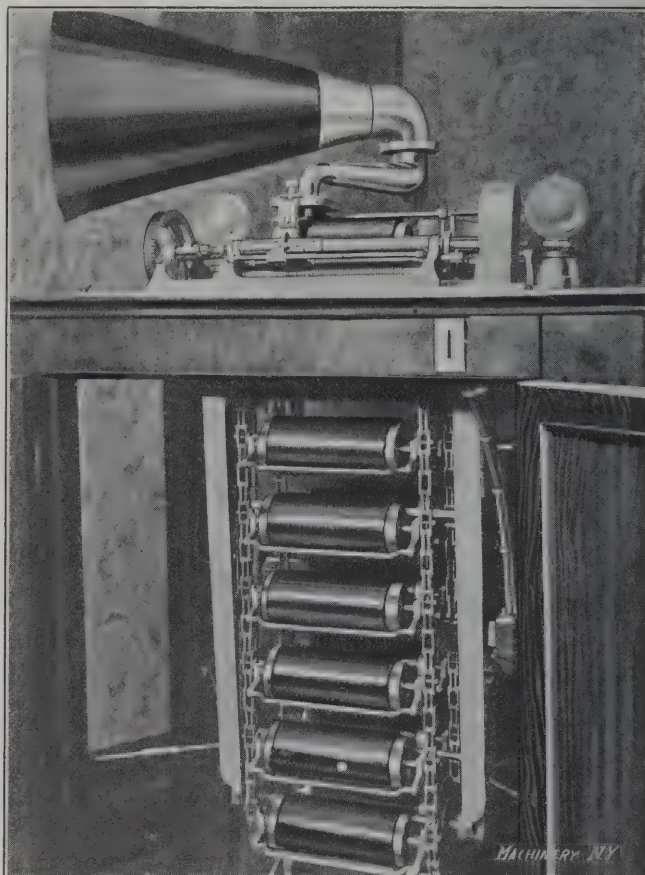
It will be seen that this formula is identical with the one given for planing Acme thread tools in the May, 1905, issue of MACHINERY.—EDITOR.]

By substituting the values for the angular functions in the formula above, we find $\tan z = 0.31174$, which gives us $z = 17$ deg. 19 min., nearly.

The result found can best be used by grinding an angular cutter to this angle as accurately as needed, gaging with a vernier bevel protractor, stoning it, and scraping the master tool with it. This was done, and the angle obtained was so close to 15 degrees that the closest inspection with the magnifying glass failed to show any error in the tool.

CONTINUOUS PERFORMANCE PHONOGRAPH

Thorns grow with roses—evil may come out of good. It is not quite unknown that even the humble and industrious phonograph can be diverted from its peaceful pursuit and used, alas! as an instrument of torture. Many defenseless neighbors have been serenaded by conscienceless individuals with ragtime, classical and religious selections until their nerves and tempers were badly "frazzled." The drawback to the use of the phonograph for such unneighborly acts is the constant attention required of the tormentor to change the records, wind the machine and set it in motion. His own endurance may flag after hours of performance and, perforce, he will seek his bed in sheer weariness of evil-doing without, it may be, having reduced his enemies to a state of complete physical, mental and moral collapse. What is needed for this sort of warfare is a "continuous performance" machine, driven by a motor, that can be started on a choice selection of the "gold molded" and left in the solitude of its chamber, the



The Iddings "Multinola," or Continuous Phonograph

horn facing the open window to do its malevolent work through the long hours of the stilly night without rest—or hesitation at the most frightful threats.

It is characteristic of American ingenuity to discover and fill wants before they are even vaguely felt by the mass of unthinking humanity. Lo! the wished-for machine is even now in our midst, and the dreadful tortures that were dimly forecasted by hand-worked phonographs will soon, no doubt, be realized by many writhing victims who, cursing inventors and all their works, die miserably to the sound of phonographic ragtime. Behold in the illustration of the "Multinola" by Dr. George L. Iddings of Cleveland, Ohio, a devilishly ingenious mechanism that changes its own records with cunning and despatch, and proceeds relentlessly, having no bowels of compassion whatsoever. The roosters crow and crow again at the dawn; the dogs bark when the moon is full; the cuckoo clock cuckoos, and is done, but the continuous phonograph goes on like the brook—forever. Yea, verily!

* * *

Contracts have been awarded for steam turbines to drive the new 26,000-ton battleships *Wyoming* and *Arkansas*. It has been stated that a combination of turbines and reciprocating engines was considered, but the authorities decided in favor of Parsons turbines.

OLD NEW ENGLAND WATER-WHEEL

ALLEN HAMMOND*

Some interesting features of an old water-wheel which was built by the Franklin Foundry & Machinery Co., of Providence, R. I., and erected in the New England company's mill in the year 1860, are shown in the accompanying engravings. The wheel was started in November of the year of its erection, and, with the exception of about a year, it has run regularly since that time. In spite of its forty-eight years of service, the wheel was in such good condition at the time of its removal, judging from the appearance of the woodwork, that it was capable of running for twenty-five years more. It was of the type known as a breast wheel, and was 24 feet in diameter by 18 feet in width.

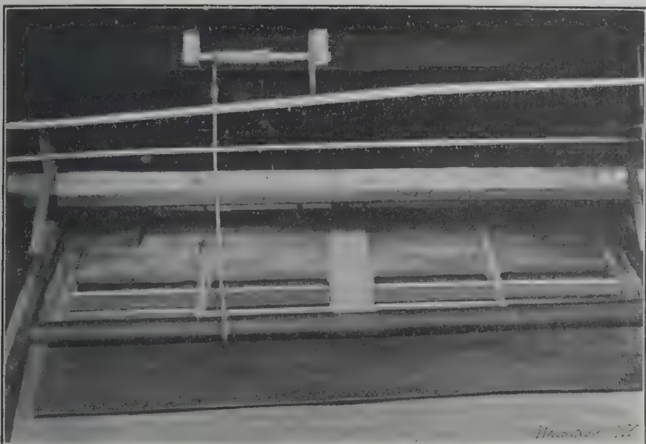


Fig. 1. Curtain Gate which, in conjunction with a Governor, controlled the Flow of Water to the Wheel

The breast or bottom of the flume through which the water entered into the buckets, was approximately 5 feet, 10 inches above the center of the wheel. The flow of water was regulated by a governor having a differential gear which gave power enough to work a long roll on which an "apron," extending across the breast, was wound and unwound up or down on the convex face of the breast. This apron, which is shown in Fig. 1, was made of sheet rubber and was fastened at the lower edge so as to be water-tight. The roll was

Fig. 2. Rack and Pinion by which the Curtain was wound or unwound

counterweighted and it was moved by a shrouded pinion, which meshed with a rack free to move on the face of the breast. This rack had the teeth cut away at each end, and when the pinion came to this smooth surface, the roll reached the limit of its travel, owing to the lack of teeth on the rack which prevented further movement. The end of the rack was provided with a flange-like tooth or projection, which prevented it from moving out from under the pinion. Both pinion and rack are shown quite clearly in Fig. 2. The counterweight attached to the roll was heavy enough so that after the latter reached the limit of its travel, the pinion would be kept in contact with the rack; hence the teeth of the pinion readily came into engagement with the rack when its motion was reversed by the governor.

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Guide vanes were inserted in the breast so that the water entered the buckets perpendicularly. These vanes, which may be seen in Fig. 1, were made of wood which was driven into castings that formed part of the breast. They were 6 inches

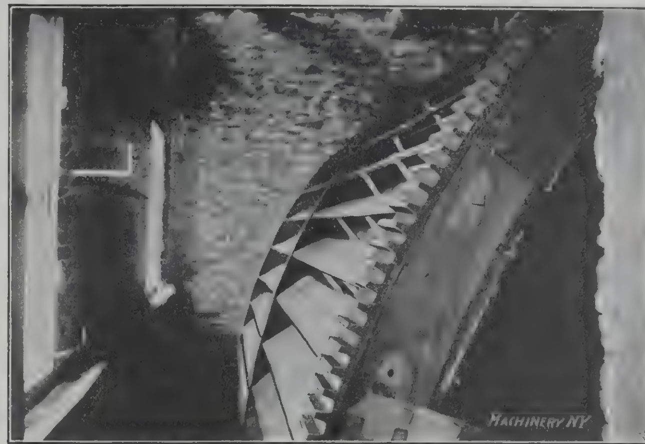


Fig. 3. View of the Back of the Wheel showing part of Driving Gear and Method of Bracing Buckets

wide and 3½ inches apart. The space between the buckets at the top was 10 inches and at the bottom 4 inches, and the angle between each bucket and periphery of the wheel was 36 degrees.

To prevent the air from being pocketed in the buckets, openings were made in the bottom which allowed the air to

Fig. 4. Spokes and Bracing at the Center of the Wheel which was without a Shaft

escape and the lower buckets to be partly filled. These buckets were set into grooves in the rim and were secured in place by spacers and bolts, as shown in Fig. 3, which is a view of the back of the wheel. In this illustration the driving segments on the rim are also shown.

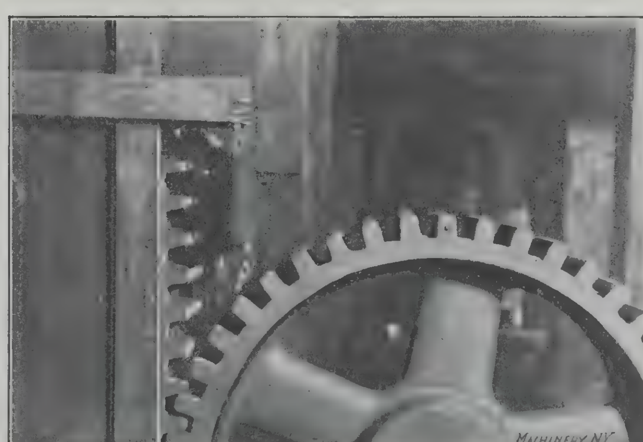


Fig. 5. Section of the Driving Gear, and "Jack" Gear with which it meshed

One unusual and interesting feature of this wheel is that it had no shaft, as will be seen by examining Fig. 4, which quite clearly shows the construction. The spokes and braces rested on flanges which were separated by wooden spacers through which long bolts passed from one side of the wheel to

the other, clamping it together. One of these bolts is clearly shown in the view just referred to. The spokes were 11½ inches by 4¾ inches, while the braces were 4½ inches by 5 inches. The segments of the rim were 11 inches by 12 inches. The bearings or gudgeons of the wheel were 10 inches in diameter by 11½ inches long.

Fig. 5 shows a section of the segment on the rim and also the "jack" gear, which was one of a set of three gears that was used for driving the mill. This gear had 44 teeth, 2½ inches circular pitch, and a face width of 7 inches. The second gear of the train had 114 teeth, and it was meshed with one having 38 teeth. The drive from the second shaft was by belts which ran over pulleys or drums, and some of these belts were as old or nearly as old as the wheel itself. In fact, one is said to have been older, it having been in use since about 1847. This wheel has worn out several sets of segments during its long and useful life.

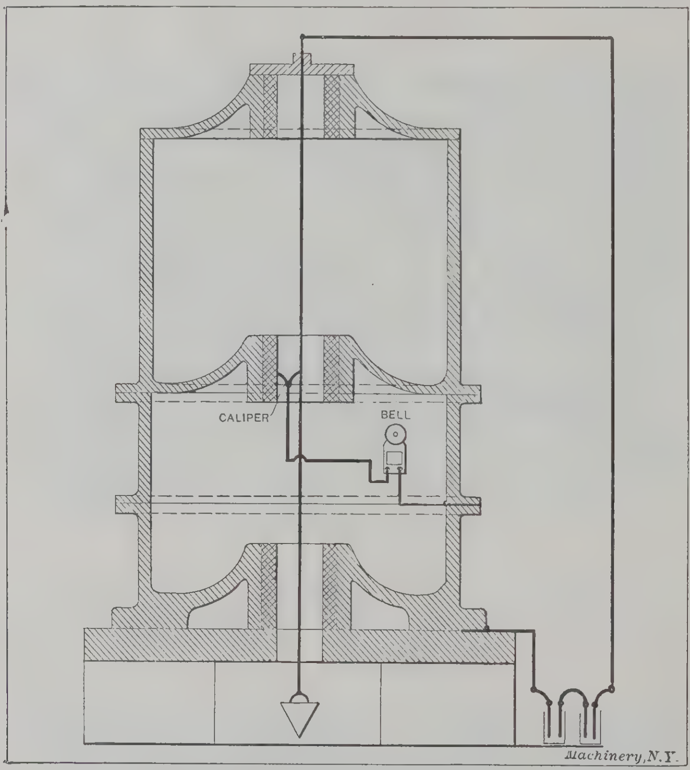
* * *

ASSEMBLING VERTICAL HIGH-SPEED TURBINES

HOWARD M. NICHOLS*

The following method of assembling and lining up vertical steam turbines is employed in one of the large turbine works, and the same general scheme could be used in erecting most any large vertical machine.

The bed-plate is set on a special iron erecting floor and is very carefully leveled, and the turbine is then assembled



Aligning Vertical Turbine Bearings by the Aid of an Electric Caliper

without the shaft and rotating parts. The wheel casing, bearing brackets, bearings, generator stator, and all other stationary parts are bolted in place. The bolts are left a little slack so that the parts can be slightly shifted during the process of lining up. A length of steel piano wire is weighted with a heavy plumb-bob and is suspended from the exact center of the top bearing, as shown in the accompanying illustration. Since the machine has been carefully leveled during the process of erection, the piano wire will locate the exact center of the shaft. The wire is suspended from the top bearing by a block of hard wood and is not allowed to come in contact with any metal part. The end of the piano wire is connected to one pole of a few cells of dry battery, while the other pole of the battery is grounded onto the frame of the turbine. One binding post of an electric bell is also grounded onto the turbine frame, and the other is connected to a pair of inside calipers by a long flexible lamp cord as shown. These calipers are used to locate the middle and lower bearings central with the center of the turbine shaft, as represented by the piano wire.

In calipering, whenever the calipers just touch both the inside of the bearing and the piano wire, the bell will ring and thus give the workman a better indication than he could obtain by the sense of touch. If it is so desired, a small battery lamp can be used in place of the bell with equally good results. After the bearings are located exactly central with the center of the shaft, the parts are doweled together and then taken down and reassembled with the shaft and other rotating parts in place.

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* * *

GAS ENGINES IN SHOPS

A. S. ATKINSON*

Generally speaking, the gas engine is rapidly becoming an important factor in machine shop work, and the facility it furnishes in operating cutting, stamping and machine tools, makes it of widespread importance to the trade. Until quite recently the installation of any kind of gas engine for shop and factory purposes was of such limited scope that the question of cost and maintenance was not seriously considered; but now that the gas engine for small as well as large shops has come to stay, any data that will throw light upon the subject should be of more or less value.

Economy in operation is the one thing aimed at, and this, in the case of the gas engine, means an economy in fuel. In my experience with gas engines in shops where only a part of the whole number of machines are in use at one time, the mistake is frequently made of installing an engine which is too large. Suppose, for example, a shop with half a dozen machines requires a full 15-horse-power engine to drive them all at once; but an examination of the records shows that only half these machines are in operation for the greater part of the time, and only occasionally does the work demand the running of them all at once, and then only for a limited period. What power engine should such a shop have to produce the most economical results? This is a point that engineers and manufacturers differ on. One will say the full 15-horse-power, and another ten or even eight, which will allow a fair margin over the average requirement. Here is an experience of the writer. A shop that had run along nicely with an 8-horse-power gas engine was enlarged by the addition of three more machines. The question arose as to the increase of the power. One engineer advocated the withdrawal of the inadequate 8-horse-power engine and the substitution of a 15-horse-power engine. Another recommended the installation of an auxiliary engine of 7 horse-power. A compromise was made by purchasing a small 6-horse-power motor, which could be coupled and uncoupled by belt to the line shafting as needed. The economy of this was shown in the first year's work. The auxiliary engine was used only 120 hours that year. For the rest of the time the old 8-horse-power engine did all the work, for the work was of such a character that only a part of the total number of machines was in use at once during the greater part of the time.

There must be some allowance for overload made in every shop, or otherwise work during rush times must be handicapped. It is unsafe to depend upon an 8- or 10-horse-power engine in a 15-horse-power shop, but does not the single big engine waste fuel where a medium-size one and a smaller auxiliary will save it? This is a question that a shop manager must consider carefully. To get fuel economy out of an engine, it should be run at something like its normal capacity. We cannot expect economy in using an engine twice as large as is required to do the normal work. On the other hand, in a shop where nearly all of the machines are needed in operation for the greater part of the time, the problem is easier of solution. The big engine is then more economical than two smaller engines, as there is less waste through friction and slipping, and less expense in operation in other ways. The cost of maintenance of two small engines is greater than a single big one of equal horse-power.

The location of the gas engine is also of importance. It should be somewhere near the middle of the long line of

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shafting if the different machines require about the same amount of power. An engine installed at one end of a line of long shafting must of necessity lose much of its effectiveness. Where a smaller auxiliary is used this should be installed with a view to running special machines not often in use. These should be grouped, so far as possible, at one end of the shafting, and in such a way that when the auxiliary is started up it will exert its power directly upon these machines. This means an equipment which will permit the cutting off of at least a part of the line shafting when not needed. It costs a little more in the initial installation to secure this result, but the saving in fuel far more than counterbalances it in the end. If there is a heavy planer at one end that requires considerably more power than any of the other machines, the engine should be located pretty close to it, but on the side nearest the other group of machines.

The gas engine has not been satisfactory in many shops through the inability of the operators to understand the new power plant. Gas engineering is a distinct and new branch, and it is impossible for an old steam engineer or one accustomed to electric drives to change to the gas engine without experiencing some difficulties. Not infrequently, engineers look upon the gas engine as such a simple machine that anybody can understand its operation without much previous study and experience. It is one of the simplest and easiest engines to operate, but it does not follow that it can be run by an ignorant man, and without some technical skill. To some extent the gas engine manufacturers are largely at fault; in their zeal to advertise their goods they say that a child can run their engines and that it takes no skill to manage them. Nothing is further from the truth. Your gas engine can get out of order and run poorly, consuming twice as much fuel as it should, if you do not understand it. The symptoms of gas engine troubles should be understood just as much as those of the steam engine or electric motor. In my experience with gas engines for shop work I have found that the symptoms of trouble are generally indicated by pounding, excessive fuel consumption, back firing, heavy explosions at the exhaust, smoke, poor speed regulation, difficulty in starting, and general lack of power. These symptoms of trouble should all be understood by the engineer, and if understood the difficulty can be quickly regulated. The life of a gas engine depends entirely upon how well it is handled at all times, and here is where the skill of the operator counts. With a thorough knowledge of the meaning of the different symptoms of trouble, the engineer can quickly apply the remedy. Pounding is generally due to the fact that the engine and gasoline are too cold. This trouble is particularly noticeable in winter and in cold climates where the engine is exposed. In a shop where the heating is good it is not so noticeable. The air intake pipe may be too cold, and the gasoline for the first charge may also be too cold. Sometimes the pounding at starting is due entirely to the jacket water being turned on too freely or too soon.

Where there is excessive fuel consumption it can be stopped by a little study of the conditions. The most common cause is the use of poor or dirty gasoline which has not been strained. Straining of the fuel should always be attended to. Water in the gasoline or cylinder will cause excessive waste. Sometimes the waste is due to defective cylinder or cylinder head castings; in such cases there is no remedy except to put it up to the manufacturers and make them furnish new parts. Again the excessive consumption of fuel may be caused by cylinder gaskets being leaky or, as sometimes happens, by their being blown out. The remedy may be applied in such cases without much trouble.

Back firing is often simply the result of incorrect setting of the spark or valve mechanism, and until this is remedied the trouble will persist. If back firing is noticeable, look for the cause first in the spark, and see if it is not out of time; in the make-and-break system the spark points may not touch. If the ignition system is all right, then examine the exhaust valve which may be out of time, or as often happens, may not close or fully open. Finally, see if the governor mechanism is not out of adjustment. Any one or all of these troubles may be caused by incorrect setting at the beginning, and proper adjustment will remove the whole difficulty. Heavy explosions at the exhaust may be due to defective ignition or because the mixture is too weak. Smoke at the end of the exhaust pipe generally means that lubricating oil is being wasted. If the smoke is of a bluish color this is quite evident, but if it is black it indicates that the mixture is too rich. If the smoke appears at the open end of the cylinder there may be a sand hole in the cylinder or a leak past the piston ring.

Poor speed regulation may be caused by defective ignition or because the governor is not properly adjusted. Again it may be caused by lack of proper lubrication of parts, or incorrect mixture. Sometimes moving parts are gummed and bind so that the regulation is very poor. If there is any lost motion in the moving parts the speed regulation must be imperfect.

Difficulty in starting is sometimes experienced and causes a great deal of trouble. This may be due to any one of many troubles, the removal of which may prevent other troubles developing later. First ascertain whether the fuel is being supplied in sufficient quantities. This is the most fruitful cause. Next examine the ignition system, and then ascertain if the mixture is properly proportioned. A cold engine or cold gasoline will sometimes cause difficulty in starting. If batteries are too weak, the spark coil defective, or if the sparking circuits are short circuited by dust and dirt, naturally there will be trouble. Too much emphasis cannot be placed upon the necessity of keeping the ignition system clean and in perfect order. This is the main part of the system, the nerves of the engine, as it were.

General lack of power may be caused by insufficient fuel or incorrect mixture also. Overheating and friction of engine parts are other fruitful causes. Likewise insufficient cooling water and insufficient lubrication will cause general lack of power in the engine. Frequently the whole trouble can be traced to a poor grade of lubricating oil which gums the moving parts and prevents free action. Heating of the piston by pre-ignition has caused many an engine to give poor results. Another thing to look for is the heating of the piston by escaping gases. There may be leaks in the compression chamber which may be the result of worn or bent valve stems or weak or broken valve springs. In new engines this trouble will not be noticeable, but others equally important will show. For instance the piston rings may not be true in circular form or they may be set with all breaks in line, thus causing a leak. In new engines sometimes the piston rings stick in the grooves and cause a constant leak. If the valve cages are not properly packed or ground into place there will be a general lack of power. In old engines dust or dirt in the carburetor, air passages, or admission valves, may be responsible for the trouble.

One does not have to study these possible defective points long before being convinced that an intimate knowledge of the gas engine and its parts is essential to good economical operation. Many times the same defect shows itself in one or more symptoms, and to remove the cause is to give the engine immediate freedom of action. Sometimes, for example, an exhaust pipe causes all of the symptoms. It is too long, too small, or has too many bends in it to permit a free expulsion of the exhaust gases. As a result the engine is constantly clogged in its operation, and other troubles will quickly set in. The only way to handle a gas engine is to find out the trouble when the first symptom shows itself. Then its life will be greatly prolonged, and there will be an economy of operation.

* * *

What are claimed to be the two largest shears of the lever type ever built have recently been completed by the Mesta Machine Co. for the Indiana Steel Co., to be used at the steel plant at Gary, Ind. The knives of the shears are 36 inches long and will make 12 cuts per minute, cutting off cold soft steel 6½ inches square or 7 inches round. Each of the machines is driven by a 150 horse-power induction motor. The total weight of each shear, not including the motor, is 112½ tons.

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MACHINERY

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

JANUARY, 1910

PAID CIRCULATION FOR DECEMBER, 1909, 23,041 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

IMPRACTICABLE IDEALS IN INDUSTRIAL EDUCATION

There is danger that the leaders in the movement for industrial education will aim too high, and that the courses of instruction will suffer from the same false reasoning which has based our high school courses on college entrance requirements. There is grave danger that the primary aim will be to enlarge on fundamental principles in a way that would appeal to the exceptional boy who is to become a superintendent or general manager, instead of helping the average workman directly with the problems of his daily work.

The danger of such a course lies in two directions. In the first place, it is exceedingly difficult to keep boys interested in studies which they see no opportunity to apply practically. In the second place, there is the ever-present possibility of spoiling good workmen by inspiring them with ambitions for positions which they are incapable of filling.

There is no injustice to the exceptional boy in this setting of a low standard for industrial education. He can readily be interested in the instruction, elementary though it may be, and once in contact with other students of lesser abilities, his own attainments stand out in high relief, permitting him to be picked out from the bunch and given such advice and assistance as he may need in preparing himself for better things.

Don't aim too high.

* * *

APPRENTICESHIP CONDITIONS

The difficulties which surround the apprenticeship question have been a subject of discussion for many years, and will continue to be until employers and apprentices get closer together than they now are on some points of difference. On the manufacturers' side we hear of the reluctance of young men to learn a profitable trade, and the difficulty of holding them to the terms of apprenticeship contracts. The young men look at the low wages they receive as apprentices, and make no allowance for the time spent in teaching them a trade which will greatly increase their future earning capacity. If the average young man can earn a couple of dollars a week more in some other and possibly easier occupation, he is seldom likely to sacrifice that amount of money to acquire a trade at which in a few years he can earn twice as much as in some occupation that offers little chance of development. The question really narrows down to this—Is the manufacturer willing to pay more than his apprentices' services are worth to him, either on account of the general benefit to his industry, or because it will pay him in future to educate such employes for his own organization? That this policy does pay has been satisfactorily demonstrated by many of the largest concerns in the country, who still maintain their apprenticeship system at more or less loss to themselves. The present need is for an action of the employers which will attract the boys and hold them.

The indentured apprentice of fifty years ago would be as much out of place under present conditions as the spinning lathe, the hand loom and the flail of our grandfathers' time. The master-and-servant situation was but one step removed from the days of the bond slave, and many of the cruelties of slavery were felt by the old-time apprentice. He was poorly paid, had to work long hours, often slept in the master's house and ate at his table, and could be corporally punished for delinquencies. To-day, of course, most of these conditions no longer exist. The manufacturing business has developed beyond the wildest dream of the old-time employer of a few men, and the apprentices of to-day are treated as well as journeymen in the matter of working hours, shop surroundings and other working conditions. But in addition to these improvements, apprentices of the desirable sort apparently must be attracted to the machine shop by higher wages and an educational campaign which will clearly make known to the average boy and man the possibilities that lie before the good machinist and toolmaker, as compared with other trades or the professions. Although in some places trade union rules are a strong deterring force, low wages at the start and ignorance of the chances for improvement are much to blame for the reluctance of young men to enter these trades. The boy sees chiefly the grime and the forbidding conditions that are common to many shops, and does not understand that brains and ability count for as much in those gloomy interiors as in the counting house or department store, with the chances for rapid promotion and good wages much greater.

* * *

THE FUTURE OF THE MACHINE TOOL INDUSTRY

A prospectus recently sent out by one of the great New York banking houses setting forth the stability and value of a new security which they are offering to investors, inspires a comparison between substantial enterprises of that character which offer legitimate opportunities for investment, and the machine tool industry as a whole.

The development of manufacturing in America is still in its infancy, notwithstanding the enormous investment already made therein and the number of men employed. Every increase in its many ramifications will call for more and more of the tools required for building all kinds of machinery—that is, machine tools. The automobile industry alone has absorbed a large number, and will continue to absorb more for some time to come, although no doubt in a diminishing ratio. Then, supplementing the demand from automobile manufacturers, will come that of the automobile and gas engine repair shops which in time will dot the country roads in somewhat fewer numbers, perhaps, than the blacksmith shops now employed in shoeing horses and repairing wagons and farming utensils—and each of the former will require at least one lathe, shaper, drill and grinder.

The railroads are large users of machine tools already; but their potentiality as buyers in the machine tool market is enormously greater. The present equipment of many railroad repair shops is of the poorest character imaginable, the tools frequently being of a type obsolete twenty or thirty years ago. The development of high speed steel and the great increase in power and capacity of locomotives, have already put many of these old tools out of commission, and still greater numbers must be thrown out and replaced by modern tools as soon as railroad earnings warrant the necessary expenditure.

In several other directions we can see a great and widening demand for machine tools—a demand that will be larger than the present manufacturers can supply unless the capacity of their plants is greatly increased. Many new concerns will therefore start the manufacture of standard and special machine tools within the next decade, because the industry is a stable and profitable one, and as the field widens its product is less liable to fluctuations in demand than heretofore. The machine tool business is therefore one to inspire the confidence of hard-headed business men who want to know that their money is safely invested where it will yield a fair return and multiply.

Much depends in the machine tool industry on business ability,—more than mechanics generally think; but the talent required for the organization and management of new machine tool concerns exists in the trade, and the next ten years will doubtless see many mechanics who have the ambition and ability leave the bench and strike out for themselves, at the head of new enterprises.

* * *

HAND AND AUTOMATIC TURRET LATHES

In December MACHINERY we published an article on shop practice which included many excellent examples of operations on the hand-operated turret lathe. In the current number is an article containing descriptions of several equally interesting operations performed on the automatic turret lathe. While the work in the two cases is somewhat different, it is conceivable that if these two shops should swap managing officers, the methods of machining would change with the management, and that the work, in time, would be changed from hand to automatic machines and *vice versa*.

The condition mentioned is an important one. It meets every machine manufacturer in the country, and a close understanding of the subject is most essential. There is, of course, no fundamental competition between the two methods of machining. Each is supreme in its own field, and it is only on work which is on the border land between the two classes that any uncertainty should be felt. We are going to try to present, briefly, the considerations which should guide the manufacturer in deciding to which class his work belongs.

First let us consider the advantages of hand-operated machines. The hand turret lathe receives constant supervision which renders it less liable to shut-downs from any cause save that of neglect of duty. Accuracy in the work can be maintained with more rapid tool deterioration, and consequently with heavier cuts, due to the feature of constant supervision, combined, in a well-designed machine, with ease in changing and adjusting the tools. Changes of tools and adjustments can be more quickly made, and less complicated tools are required, profitably adapting the machine to smaller lots than the automatic machine can be rigged up for. The same factors also facilitate changes and improvements in the product.

Another and most important advantage of the hand machine is the higher output possible per dollar of capital investment, because the machine itself and the tool equipment are less expensive, and under many conditions a higher output per machine is possible. Again the profitable use of the hand machine on small lots permits the rapid flow of work through the shop, with a consequent reduction of the capital tied up in work in progress. All these factors—the less expensive machines and tools, the possibly smaller number of machines, and the smaller stock of rough and finished parts—are reflected in smaller and more compact buildings, with the consequent reduced expense for interest, insurance, taxes, salaries and other overhead expense.

The advantages of the automatic machine may be summarized as follows: It makes possible a lower labor cost per piece, and this is true practically in all the conditions under which the automatic machine would be considered. It may be arranged to take full advantage of the possibilities of using multiple tools, and on a large proportion of turret machine work this means that the hand machine will be unable to produce the same output per machine, in spite of the closer personal supervision which the latter receives from the workman. In the matter of accuracy it may be assumed that with properly arranged tools and proper setting up, the invariable mechanical action of the automatic machine is highly suited to the production of accurate work, uniform in all its important dimensions.

Besides those just mentioned, the automatic possesses other advantages over the hand machine which must appeal to shop managers from the standpoint of administration. It does not cease to be productive, even if the operator leaves it for a time, and it does not stop until its work is completed. One skilled mechanic can supervise the work of a large number of machines, and the direct attendance of the machine, for keeping it supplied with work and inspecting its operation, can be left to a less expensive grade of labor. This consideration means also a more flexible organization, as it is easier to shift men from one machine to another.

High production for a given piece on the hand turret lathe comes in part from the skill of the operator on that particular piece, and is checked for the time being by shifting to work of another character. The same considerations also apply in the matter of breaking in new men to the work. Attendants for the automatic machine, sufficiently skilled for its requirements, can be obtained with little trouble. The importance of these considerations can best be understood by those actively engaged in shop management.

In balancing the various advantages and disadvantages mentioned above, the shop manager should take into consideration the conditions covering his particular case, among which may be mentioned the following: Is the work of such a character that the multiple cuts obtainable from the automatic machine can be used? Are changes in the design or character of the work sufficiently frequent to make the adaptability of the hand machine an important consideration? Is the product built in sufficiently large lots to make automatic machines profitable? Is the capital available for the business sufficient to warrant larger initial expense when the more expensive machines figure out to be cheaper in the long run? Is the product of the shop, as determined by careful analysis of accurate cost accounts, of such a character that the labor cost is relatively high, or relatively low, as compared with the charges for material, overhead expense and interest? What are the labor conditions? Are wages for good men relatively high or low? Is the working population a shifting one, and is there a large supply of skilled workmen to be drawn on?

It will be seen that this problem is one difficult to solve by purely logical, mathematical processes of reasoning. The factors are too many and too complicated. Reasoning will carry the shop manager part way toward his conclusion. But when all the facts in the case have been gathered, in coming to a final decision from them that necessary and indefinable attribute we call "judgment" will have to be invoked.

We cannot refrain from calling attention to one point in which the automatic machines, in general, have a fundamental advantage over hand-operated machines engaged in the same work. This consideration may be criticised as being a purely ideal one which ought not to be considered in a practical discussion of the subject such as we have been carrying on. It is a consideration, however, which inevitably strikes the mind of the observer who has an opportunity to compare the conditions in two shops where both classes of machines are being operated with high efficiency. With hand operation, the workman tends to become the servant of the machine. The possibility of increase of production through constant supervision is so great that the operator is kept constantly on the alert in changing feeds, speeds and adjustments. With automatic operation, it is the man who is the master, and the machine the servant. It is a sight distinctly inspiring to see banks of automatic machines steadily chewing away, while the operator walks leisurely from one to the other, putting in a new piece here, examining the condition of the tool there, and occasionally changing the adjustment. This consideration, we believe, brings the automatic machine directly in line with the current of human progress.

* * *

Why don't the grinding machine operators wake up and write something of general interest on grinding?

PRACTICAL SAFEGUARDS IN THE NATIONAL CASH REGISTER CO.'S PLANT*

ETHAN VIALL†

No plant in the world is more up-to-date in every respect than is that of the National Cash Register Co. at Dayton, Ohio. It has been looked upon as a model for years, and its fame as such has attracted visitors from all over the world, over fifty thousand being shown through the various departments annually.

Every effort has been put forth and no expense spared to beautify the factory grounds, a noted landscape gardener being employed for the purpose. Employes are encouraged to buy their own homes and are given expert advice as to the best way to make them attractive. Good wages are paid, and women employes are given shorter hours than men and a recess twice a day. Rest rooms are also provided for them, and a doctor and trained nurse are within easy reach. The men are allowed twenty minutes for one shower bath a week in winter, and forty minutes or two a week in summer at the company's expense, there being 228 series of showers in the factory. No person with a contagious disease is allowed to work. Four-fifths of the wall space is glass, affording plenty of light and saving the employes' eyes. The ventilating system is as nearly perfect as modern science can make it. The company has its own laundry and furnishes clean towels and aprons twice a week, and in every possible way the employe is taken care of, not merely because the company wants to be philanthropic, but because it is sound business policy. The old, revolting idea that found expression in: "When he's dead we'll get another man just as good," has no place here; but the policy toward the employe might be expressed in this way: "We have spent time and money to train this man (or woman) in our way of doing work, and it is far easier and better to take care of him and keep him in good shape physically and mentally, than it is to neglect or mistreat him and, in consequence, have to break in a new one every few weeks or months, thereby lowering our average of efficiency, quality and output." The different ways by which all this is accomplished are almost infinite, but it isn't within the scope of this article to deal with anything more than those methods or devices by which life or limb are protected, though in many cases the margin between mechanical safeguards and sanitary ones is so narrow as to be practically indistinguishable and no attempt will be made to hold strictly to mechanical devices as such are usually defined.

Fig. 1. Two-handed Trip for Punch Press, which proved Defective

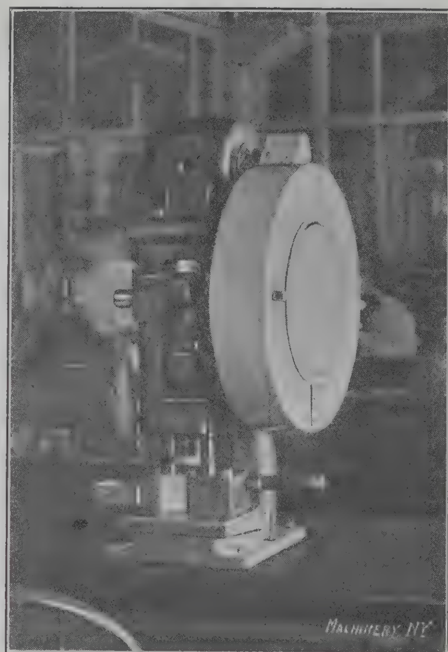

Fig. 2. Guard over Pinion and Gear of Motor-driven Press

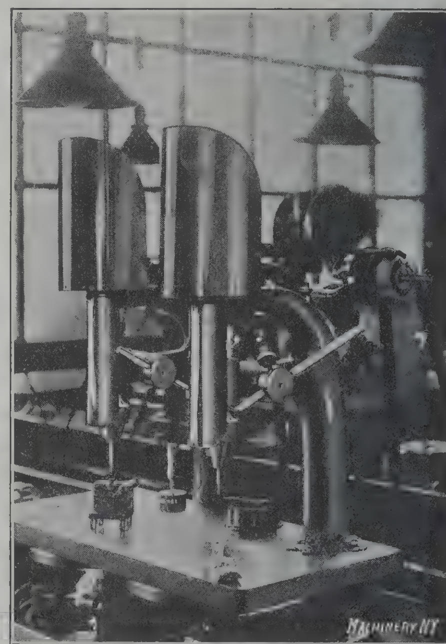

Fig. 3. Hair Guards on Small Drill Presses which are operated by Women

Probably no class of machines, unless for woodworking, has been the cause of more serious accidents than punch presses, yet no other class of machinery has had fewer successful safety devices. In many cases, on the more powerful machines, even the gearing, now almost universally covered on other machines, is left without a guard or shield of any kind, a man's finger or his arm hardly being considered worth looking out for, regardless of the fact that one damage suit is likely to cost enough to buy a hundred or even a thousand guards. Carelessness and indifference on the part of employes has, to some extent, been responsible for the lack of proper safeguards, for what an employe doesn't insist on or doesn't want, isn't usually given him, especially if it costs the employer anything. Instances are common where an operator, after a press has been fitted, at considerable expense, with an automatic lever or guard to protect the fingers or

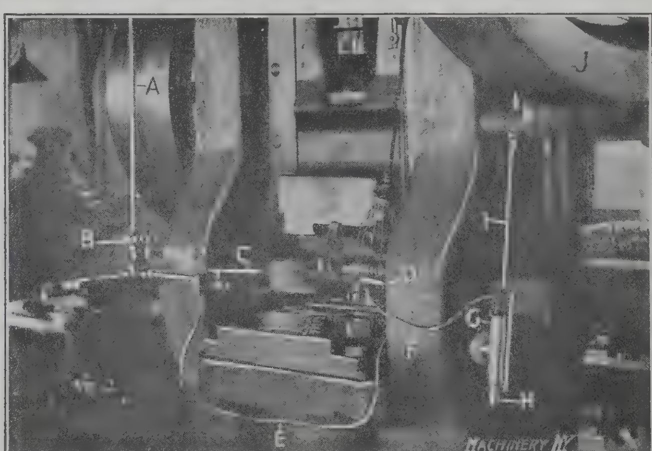

Fig. 4. Improved Two-lever Pneumatic Press Trip

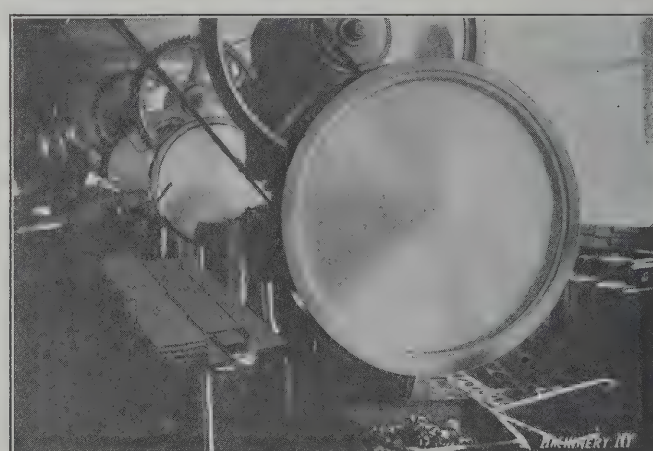

Fig. 5. Protective Shield covering Fly-wheel Spokes

* See note referring to the safety appliances used by the U. S. Steel Corporation, in MACHINERY, February, 1909.
† Associate Editor of MACHINERY.

hands from the descending punch, has, at the first opportunity, thrown it aside and gone back to the old unguarded way. Too much trouble is the verdict, but it *isn't* too much trouble if the device is going to save a man's hand or arm, no matter what he says of it.

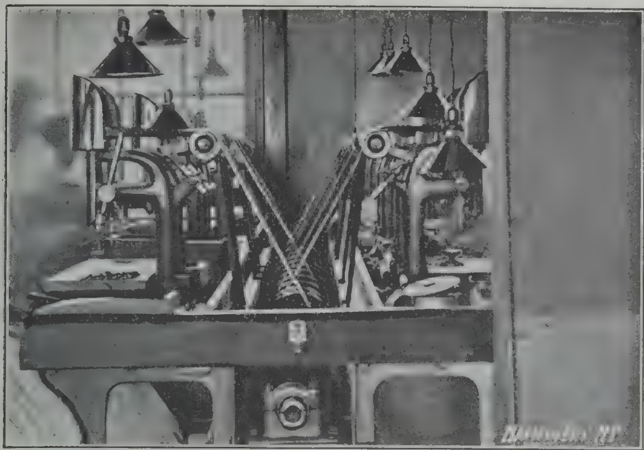

Fig. 6. Hair Guards and Arrangement of Belts and Pulleys on Small Drills

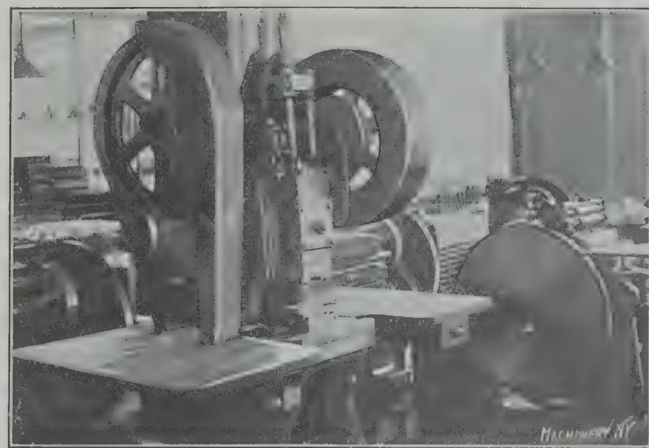

Fig. 7. Belt Guard and Fly-wheel Dress Guard

Only a few instances of discarded devices serve to convince a thinking foreman that any appliance intended to prevent a man getting his fingers under a punch, must be absolutely "fool-proof," and to devise something of this kind has been one of the hardest problems that the shop officials of the National Cash Register Co. have had to solve, but recently they hit upon what appears to be the only really successful, fool-proof appliance yet devised. It has taken a long time to work out and correctly apply the idea involved, but the principle is very simple, the whole idea being to *make the operator use both hands to trip the press and to make it impossible for him to do so unless he does use both hands.* That is the whole thing in a nutshell, and the idea is being applied to every punch press in the plant and, of course, in compelling a man to use his hands to trip the press, the dangerous foot treadle is discarded and one great source of accidents thereby eliminated, for it is so easy for something to fall on the treadle at the wrong time or for a man to stumble on it or else press his foot down unintentionally.

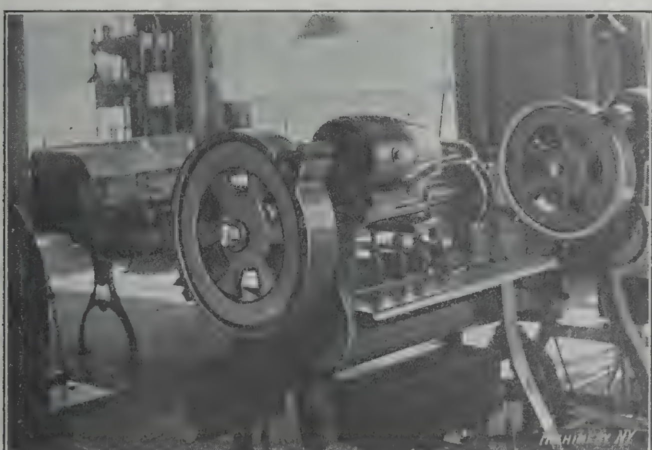

Fig. 8. Neat Style of Gear and Pinion Covers

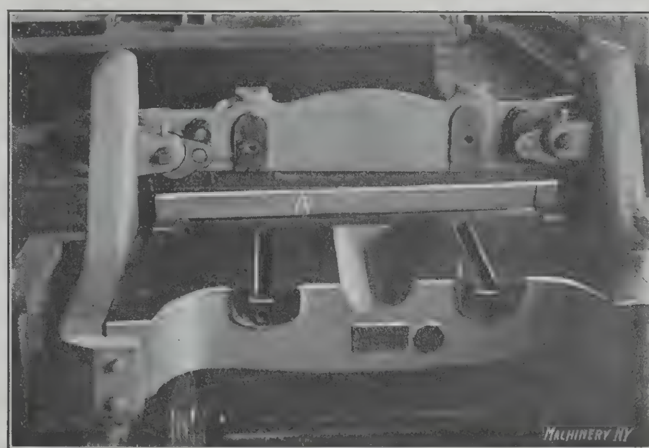

Fig. 9. Finger Guard on Small Trimming Shears

The first application of a device embodying the two-handed trip idea was on a punch press fitted with a forming punch and die, and is shown in Fig. 1. This was purely a mechanical device. Both levers had to be pulled to trip the press, as the pulling of one alone would not accomplish it, but as this device soon proved to be anything but fool-proof, it will not be described in detail. An additional safeguard on this machine consisted of an automatic air valve mechanism (shown on the left side of the press frame) and a hose which was so arranged as to direct a powerful jet of air onto the punching and blow it out of the die as the ram raised. The principal reason for condemning this lever system was that the operator, to gain a fraction of a second, would, unless watched, prop out one of the handles with a stick and work the trip with one hand, for which there was no valid excuse as the company's piece-work rates allowed a very liberal mar-

Fig. 10. Corner of a Rest-room for Women Employes

Fig. 11. View of a Corner in the Shop Hospital

gin; nevertheless the fact remained that the levers could and would be tampered with at the first opportunity, so the next move was the fitting of the pneumatic device to the presses, shown in Fig. 4, and this is practically the form of trip that is being put on all the machines at the present time. Referring to the engraving, A is the air supply pipe containing air under heavy pressure; B is a cut-off valve; C is the left-hand trip-valve lever, and D is the right-hand trip lever. Both trip-valves are of the same pattern, and are connected by the small air pipe E. The air pipe F leads from the valve D to the cylinder G, which is so arranged that when air is let into it the plunger H is forced downward, pulling the rod I with it, and thus causing the press to trip. Now to operate this trip, the line valve B is first opened, letting the air in as far as the valve C; but the pulling of lever C cannot trip the press, as the air cannot reach the cylinder until lever D is pulled, and on the other hand, the pulling of lever D alone cannot trip the press, since valve C closes automatically and shuts off the supply. It is plain, then, that if both valves are arranged to close automatically the instant the levers are released, it is impossible to trip the press unless both are held open at once. The form of the levers themselves and the angle at which they project when the valves are open, make it highly improbable that they can or will be successfully propped open. At J, in this engraving, is also shown a partial view of an excellent type of gear guard. Not only are all gears guarded as they should be, but all fly-wheel spokes are covered, where they are low enough to catch anything, as shown in Fig. 5.

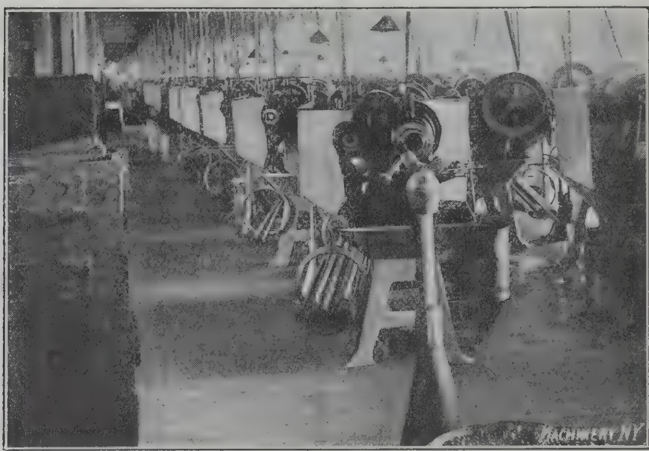

Fig. 12. Battery of 340 Automatic Screw Machines, equipped with Splash Guards

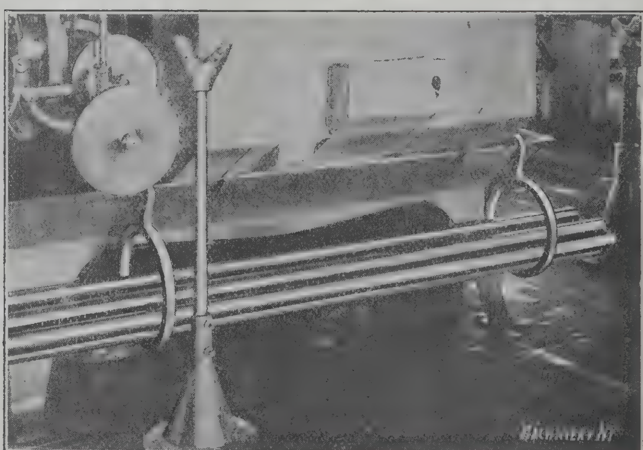

Fig. 13. Safety Stock Rack on Screw Machine

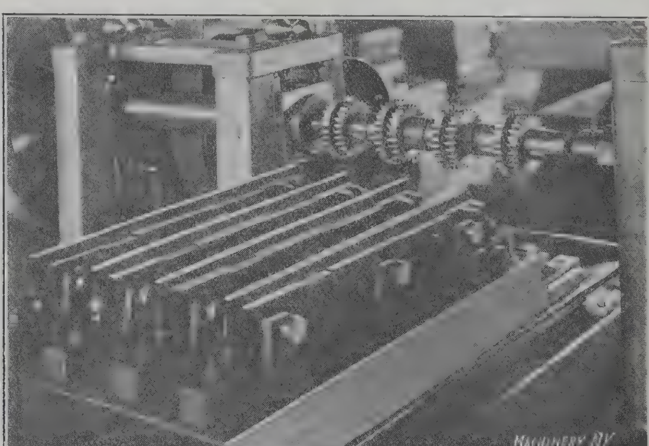

Fig. 14. View of Jig on Milling Machine, showing Clearance between it and the Cutters

In Fig. 2 is shown a good example of a covered gear and pinion on a small motor-driven press in one of the women's departments. Wherever women are employed in a shop, additional safety precautions must be taken on account of long fluffy hair and flowing skirts, and in Fig. 3, are shown two small drill presses with shields to prevent hair catching in the spindles or belts, and in Fig. 6 is shown a compact battery of these drill presses equipped with hair guards. These guards are also very effective in preventing oil being thrown on the operator. The driving belts and pulleys are arranged in such a way that it is impossible to get caught in them in any manner.

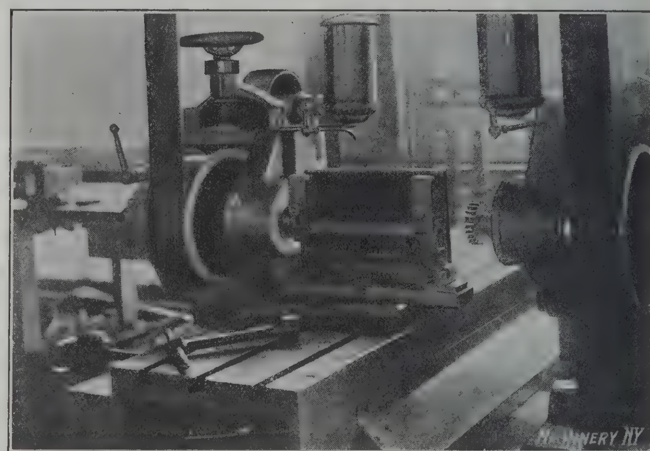

Fig. 15. View showing Position of Milling Fixture with Reference to Cutter, when Stationary

At A, Fig. 7, is shown how the low fly-wheels are guarded to keep the skirts from catching in them, and at B is shown a good belt guard. No overhead belts of any kind are allowed in the women's department, all driving being done by carefully boxed motors, and where these motors are mounted on the machines, they are carefully covered as in Fig. 8, and if belted in any way, the belts are guarded.

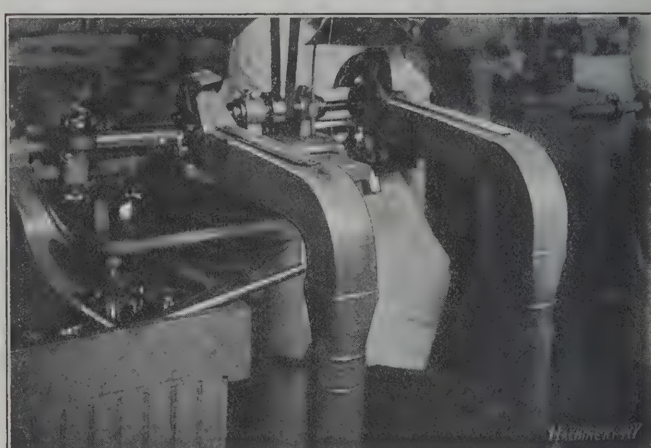

Fig. 16. Dust Pipes and Wheel Guards on Universal Grinder

To keep the operator's fingers from under the blade of the light trimming shear, Fig. 9, the guard A, has been fastened to the bed, the opening being high enough for any possible work, but not high enough for fingers.

In connection with the brief mention of the employment of women, one of their rest rooms is shown in Fig. 10, which is provided with chairs, cots, lounges and other comforts so that they may rest or lie down at any time, if sick or indisposed. In Fig. 11 is shown one corner of the hospital, where a trained nurse is always on duty during working hours, and a regular physician is within call at any time in case medical or surgical aid of any kind is needed. He also comes to the shop

hospital at a certain time each morning to prescribe for minor ills, if necessary.

Going now to the automatic screw machine department, with its three hundred and forty automatics, we find guards over gears and every other dangerous part of the mechanisms, and huge pans at the back and front of the machines, as in Fig. 12, to prevent the floor from becoming slippery and dangerous from spattered lubricant. Stock for immediate use is kept off of the floor by using the hook brackets shown in Fig. 13. Not only is this done for neatness and convenience, but also to prevent accidents caused by stepping on bars that are likely to roll.

All jigs used on milling machines and the like, are so arranged as to be drawn back and well away from the cutters while placing or removing the parts. A good example of this type of jig is shown in Fig. 14. In many cases the reversing of the table is automatic, but in all cases plenty of clearance is insisted upon, and where possible the jig, when at rest, is back of the cutters as in Fig. 15.

Great care is taken in the tool grinding room to have the exhaust pipes arranged so as to carry off all dust. In Fig. 16 is shown the adjustable wheel covers and telescoping tubes used on the regular two-wheeled universal grinders, while in Fig. 17 is shown the method of piping a grinder with a swiveling head. Every wheel in this large department is thoroughly equipped and the air is as free from dust as in any other place. Fig. 18 is a surface grinder of the planer type, equipped with a wheel guard and a large suction funnel just back of the

Fig. 17. Dusthood and Exhaust Pipe on a Swivel-head Grinder

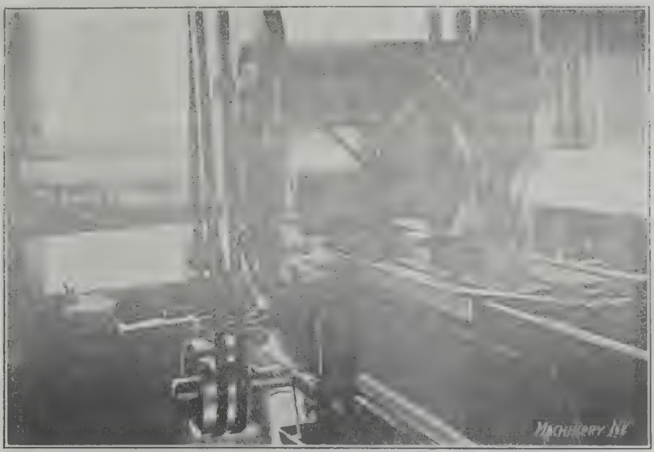

Fig. 18. Surface Grinder with Wheel Guard and Dust Funnel

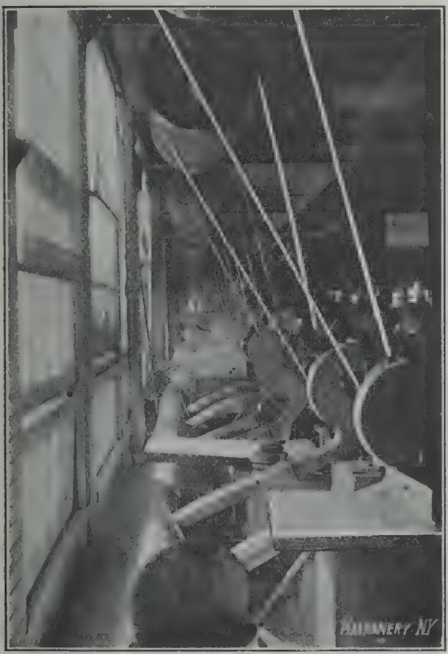

Fig. 19. Exhaust System in Polishing Room

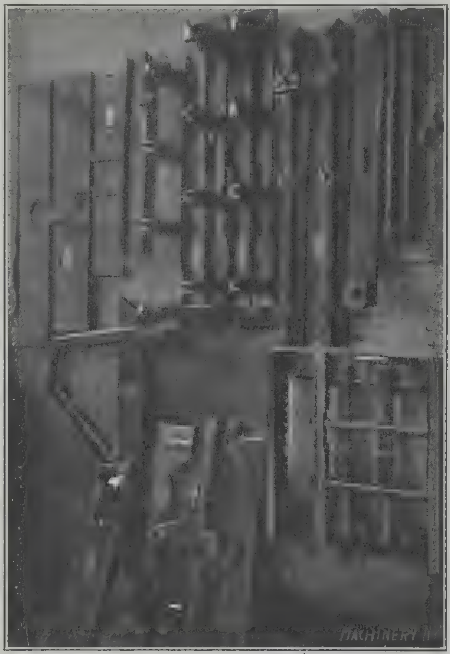

Fig. 20. Wood-working Jigs and Guards

Fig. 21. Other Wood-working Jigs and Guards

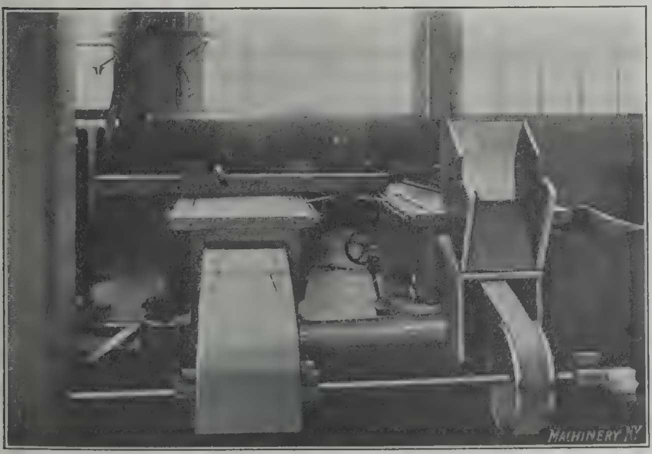

Fig. 22. Belt and Pulley Covers in the Wood Shop

Fig. 23. Exhaust Fan and Hood over Acid Vat

wheel, that catches and carries off all the metal and emery.

In the polishing department, a splendid exhaust system is in use as shown in Fig. 19, and here even the overhead pulleys have the spokes covered in order to avoid the fan action as much as possible.

In the woodworking department, there are guards of all kinds to prevent accidents, and special devices are used to cover as much of the cutters as are not actually in use. Wooden jigs are used for holding various parts while machining them on shapers, saws, etc., in order not to get the hands too close to the tools. A number of these jigs and special guards are shown in Figs. 20 and 21. All dangerous parts or places in the wood shop are painted a bright red, belts and pulleys are boxed as in Fig. 22, and band-saws are covered as much as possible.

Fig. 24. View showing Suction Openings in Plating Room

Acid and other fumes in the plating or lacquering rooms, are drawn off through hoods placed over the vats or tanks as in Fig. 23 or else by suction hoods at the back of the tanks as in Fig. 24, the powerful suction being shown by the way steam is drawn in from the tank next to the window.

The big potash tanks are equipped with mechanical dipping devices, so that the men will not get their hands into the biting stuff. This dipping machine is shown in Fig. 25. It consists of a series of cages or frames fastened by chains running over pulleys, to a reciprocating bar worked by a pulley and crank, in such a way that the cages dip up and down in the tank continually unless caught and held up by a hook or latch at the top of the framework. All but one of the frames are shown "hooked up" in the engraving. The perforated pails containing the oily parts, are placed in one of these cages and the hook pulled back; the cage then proceeds to automatically dip in and out of the potash until the operator again hooks it up. The parts are then allowed to drain awhile, after which they are removed from the bucket. Not only does this machine save the men's hands and bodies from the principal effect of the potash, but it also prevents the inhaling of the fumes that is the inevitable accompaniment of hand dipping. The machine is also a great time saver.

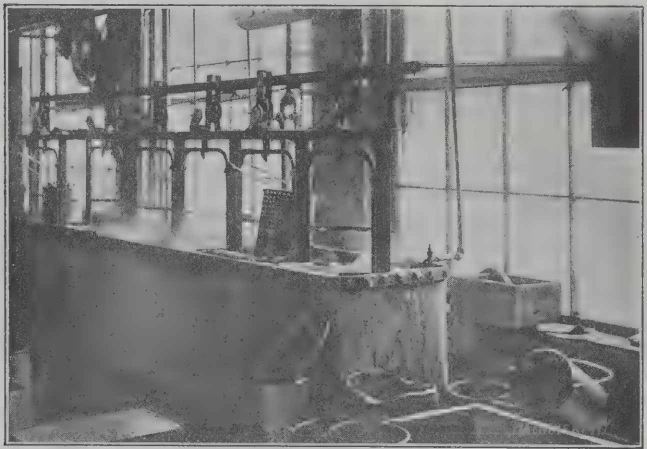

Fig. 25. Dipping Machine and Potash Tanks

Going up the stairway from one floor to the other, one notices how even the stairs are railed and guarded with heavy wire screen as in Fig. 26, and in many places where trucks have to be run up long inclines, strips or belts of a cork-like material are laid in the floor to walk on and to prevent slipping and consequent injury.

While gathering material for this article, I was greatly assisted by Mr. Reeder, manager of the Welfare Department; Mr. Sager, machine supervisor; and Superintendent Oswald; and my thanks are especially due to the last-named gentleman, whose permission and kindly interest made possible this article.

* * *

JEWELERS' WAX

ARTHUR A. RACICOT*

To make jewelers' wax, take common rosin and heat it in a vessel until it flows freely; then add plaster of paris, stirring continually while adding the powder. Care should be taken not to make the mixture too stiff. When it appears of the proper consistency, pour some of it on a slate or marble slab and allow it to cool; then insert the point of a knife under the flattened cake thus formed and try to pry it off. If it springs off with a slight metallic ring, the proportions are right; if it is gummy and ductile, there is too much rosin; if it is too brittle and crumbles, this indicates that there is too much plaster.

This what is sold for jewelers' cement at thirty cents for a half pound cake. It is used for filling gold headed canes, umbrella handles, cementing stones in ring settings, and also for holding very thin pieces of metal on a face-plate for drilling, cutting disks, or turning off the surface.

Fig. 26. Railed and Guarded Stairway

I gave this formula to a friend who had some very artistic tile for a fire-place, and after having set as many as he could one evening, he forgot that the wax only needed rewarming in order to use it the next day, so in order to keep it fresh he poured water in the iron pot; in the morning the wax had become insoluble owing to the action of the water on the plaster. So it is advisable not to wet the wax until it is put to its final use and place.

* * *

Iron castings that are too hard to machine or which have hard spots destructive to tools may be nicely annealed by packing closely in covered cast iron boxes with black manganese, and heating to a temperature of 1,500 or 1,600 degrees F. until thoroughly heated through. A large box packed in this manner with a closely-fitted cover luted with fireclay must be heated for several hours to raise the interior to the annealing temperature. To be sure of getting the interior heated properly, a number of witness wires should be placed in the box, projecting through the cover where they can be conveniently grasped with tongs and pulled out one at a time to show how far the heat has progressed. When the interior has reached a bright red heat the box should be hauled out and covered with ashes so that it will cool slowly. It is claimed that hard spots in gray iron castings can be softened with black manganese by applying the manganese and heating to a dull red, using a blow-torch or any other convenient means of heating.

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ASSEMBLING A 48-INCH MOTOR-DRIVEN PLANER—2

ALFRED SPANGENBERG*

In the previous article it was stated that the principal points to be observed in planer erection are: housings parallel with each other and square with the bed; accurate fit of all sliding members and truth of all plane bearing surfaces; proper mesh and smooth working of gears; and a system that permits the various parts to be easily and quickly assembled, and avoids the necessity of fitting the members together for the laying-out operations. In the first article boring and drilling the bed, drilling the housings, and testing the housings were described, and in this, the concluding part, we will take up laying out the arch bars, assembling operations on the bed, setting the housings, assembling the driving, feed and arch members, laying out and setting the cross-rail and the final test and inspection.

Laying Out the Arch Members

The first drilling operation on the arch is for the housing bolts, the jig for this being shown at *C*, Fig. 4; then the arch

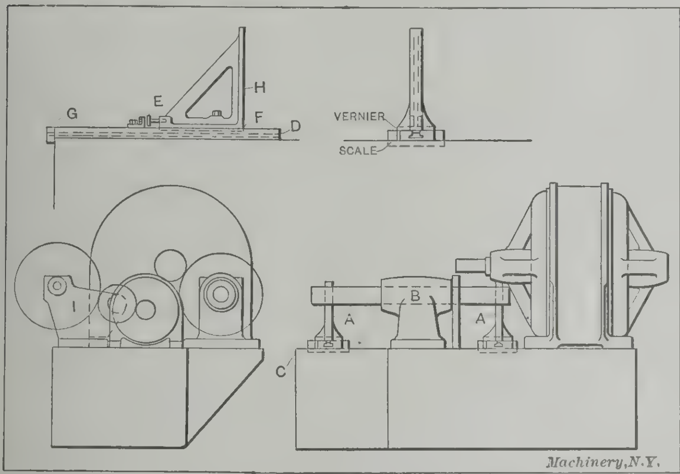

Fig. 8. Arch with Bracket Members and Motor in Position for Laying Out

is set under the drill in its normal position and the brackets and motors are located for marking off the bolt holes, as illustrated in Fig. 8. When these holes have been drilled and tapped, the arch members are bolted in place for drilling the dowel pin holes, this time more care being exercised in the setting. This is another instance where the varying character of the parts precludes the use of drill jigs, and a method of laying out the work must be resorted to. For convenience in obtaining accurate measurements, and to facilitate the work, a pair of adjustable angle-plates are used, as shown at *A*, the idea being to use an arbor in the bracket hole *B* and to provide a positive locating surface at each end, against which the arbor just touches.

The location endwise not being as particular, a line is scribed on the arch the correct distance from end *C*, and the bracket, with a scale held against the end, is set so that the edge of the scale coincides with the line just mentioned. As will be seen from the detail view, the angle-plate is adjustable on its base *D*, and may be turned end for end and clamped in any position as the case may require, fine adjustment being made by the screw *E*. Fastened to base-plate *D* is a scale, while attached to angle-plate *F* is a vernier, this combination enabling very accurate settings; all readings are taken from the lip *G* to surface *H*, and it is necessary, of course, to add half the diameter of the shaft to obtain the center distance. Bracket *I*, for the top elevating shaft, is set in the same manner, except that the angle-plates are reversed on account of the bracket being so close to the edge of the arch. With both brackets bolted fast and pinned, and their gears in place supported on short arbors, the motors are set so that their pinions mesh properly with the respective gears; then the motor clamping bolt holes are marked off, drilled and tapped, and the motors reset for pinning. In case the design is such that the entire top surface of the arch casting is not planed, *i. e.*, where finished seats are provided for the brackets and motors, additional spots are required for the angle plates. These spots are conveniently located on the casting and are finish planed with the other seats.

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Assembling Operations on the Bed

The first assembling operations proper on the bed consist of drilling the various set-screw and oil pipe holes; drilling and fitting the track oiling device, a drill jig for which is shown in Fig. 9; and assembling the rack gear, its shaft, and the two intermediate compound gears and shafts. These operations, together with placing the housings on the bed, are done before the leveling operation, as otherwise the consequent hammering and additional weight of the housings might throw the bed out of level.

During erection, the bed is supported on cast iron parallel blocks placed about six feet apart along the whole length of the bed and also under the housings. Planed cast iron wedges, having screw adjustment, are placed between the parallel blocks and the bed, thus enabling very accurate leveling to be accomplished. The arrangement of all the blocking is such that none of it will interfere with the driving and feed mechanism during erection, and as these details vary in different machines, the blocking must be arranged to suit each machine.

Several methods may be followed in leveling a planer bed, any one of which will give good results if the work is carefully done. The prime requisites are, of course, a first-class, sensitive, spirit-level—one at least 18 inches long—and an accurate parallel that will reach across both tracks. It is obvious that since the tracks in a new bed are not worn, just as good results are obtained in leveling, by using the top surface on the tracks, as by using either V-shaped parallels or cylindrical pieces in the ways. The leveling is done as follows: The level is used on the top surface of one track, and that side of the bed is carefully leveled by moving the instrument short distances at a time, over the entire length. Then, by placing the level on the parallel, the bed is leveled crosswise; the operation of first leveling one side and then cross-leveling to the other is repeated several times, or at least until no further errors can be detected.

Setting the Housings

Fig. 10 is a top view of the planer, and shows the general method of setting the housings; the operation involves the

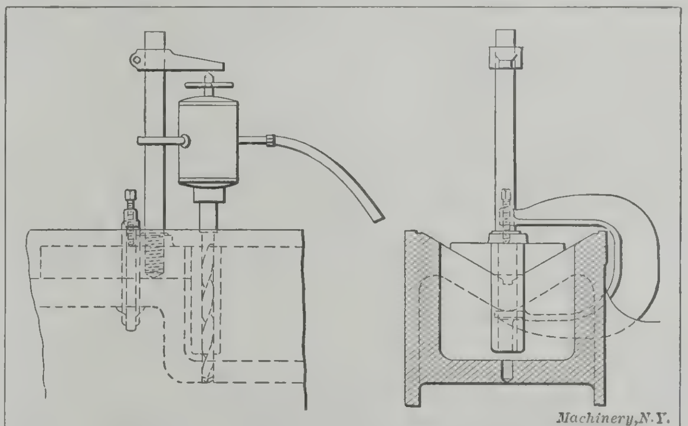


Fig. 9. Combination Drill Jig and "Old Man" for Drilling Hole in Oil Pockets for Oiling Device. Jig insures Hole being drilled in Center of Way

alignment of the driving shaft bearing in bracket *A* with that in the bed at *B*, and also includes bringing the faces of the housings into the same plane. With the housings bolted to the bed only sufficiently tight to hold them in place, and with driving shaft bracket *A* bolted and pinned fast to the front housing *C*, an arbor *D* is used as indicated. This arbor is ground true and is a wringing fit in the bed at *B*, and, being of smaller diameter where it passes through bracket *A*, permits it to be easily introduced into the bed bearing even though the bracket hole is out of alignment. This condition is possible, of course, since the clamping bolts *E* have 1/8 inch clearance in the housings. Now, with bushing *F* in position to enter hole *G*, the front housing is driven with a babbitt hammer, either forward or backward as the case may require, until the bushing enters the hole freely without springing the arbor.

To set the back housing, a straightedge is laid across the bed as shown at H, and narrow strips of tissue paper are introduced at I and I_1; then, by moving the back housing until papers I are tight and I_1 can just be moved, it is determined that both housings are in proper alignment. The fact that the outside papers are slightly loose is due to conditions already stated. After reaming the housing dowel pin holes by means of an air drill, and driving in the pins, measurement is taken for arch casting J, and the housings are calipered over surfaces K just above the bed, and at the top, to test their parallelism.

While an attempt is made at interchangeability with respect to the length of the arch member, it sometimes happens that certain elements make it necessary to slightly deviate from the standard measurement. For instance, the above test may show the measurement over K to be from 0.002 to 0.003 inch wide or narrow at the top, in which case the housings are made parallel by means of a jack-screw, or tie-rod, as the case may require, and then the arch is machined to suit. The arch is now bolted in place, and set to match the housings at L and M, after which it is pinned.

Assembling the Driving, Feed and Arch Members

The cross-rail, side-saddles, and the various driving and feed units are assembled in a department separate from the erecting department, and these parts usually are duplicated in quantities and come from the store-room to the erectors completely finished. In all cases where possible in assembling these units, standardization is provided for, and in this way much time is saved by the erectors avoiding unnecessary adjustments.

Referring back to Fig. 1, the feed box E is next bolted in place, and after assembling the driving shaft F with its members, and bolting on the bracket member G, the outboard bearing H is bolted in position. The arch bearing for the flywheel shaft I, already being secured in place, this shaft is redleaded and tried in its bearings to test their alignment. When proper care is exercised in the aligning operations, very little scraping is necessary on these bearings.

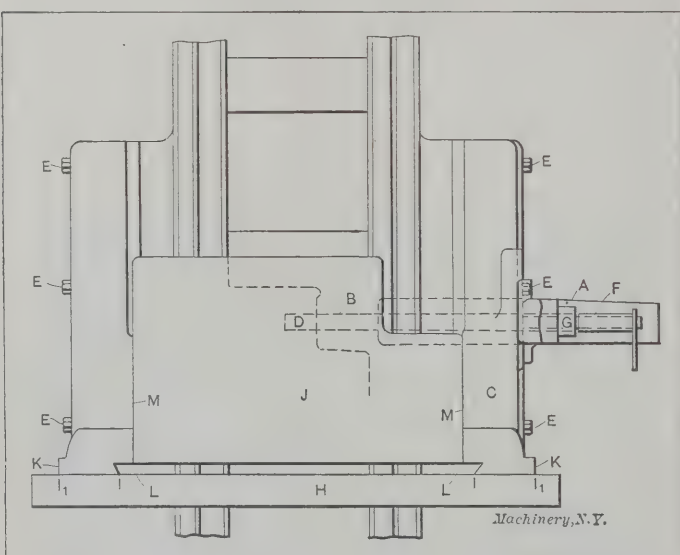


Fig. 10. Method of Setting the Housings. First the Front Housing is set for Alignment of Driving Shaft Bracket "A," then the Back Housing is brought into the Same Plane by means of Straightedge "H"

While work is proceeding in assembling the top works, elevating screws, and motors, other erectors are busy with the side-heads D, rocker mechanism J, and the feed mechanism for the side-heads and cross-rail; each unit is assembled in logical order, and as many operations as possible are carried on simultaneously. The planer is now ready for the cross-rail K and table L, preliminary work on these members being completed far enough ahead so as to cause no delay at this point.

The operations on the table consist of drilling and reaming the stop-pin holes, drilling and bolting on the rack, and rough scraping the tracks; the oil grooves were cut in the machining process. A large motor-driven multi-spindle drill is used for drilling and reaming the stop-pin holes. This machine carries sixteen spindles, arranged in two rows; one row of spindles carries the drills, and the other the combination mills and countersinks. After the first row of holes is drilled and the table is indexed along the space of one row, the combination mills and countersinks are inserted, and the sixteen tools are used simultaneously, thus producing very rapid work. The table is supported on a special truck running on a track between the drill uprights, and a suitable mechanism for moving and indexing the table completes the equipment. Previous to placing the table on the bed, the ways on the latter are also rough scraped, and then the bearing surfaces receive a coat of red lead which serves the double purpose of marking material and lubricant.

Laying Out and Setting the Cross-rail

The stud holes A for the cross-rail gibs are drilled in the manner shown in Fig. 5. As will be seen, spots are planed off at B which serve to square jigs C and C_1, and the holes for

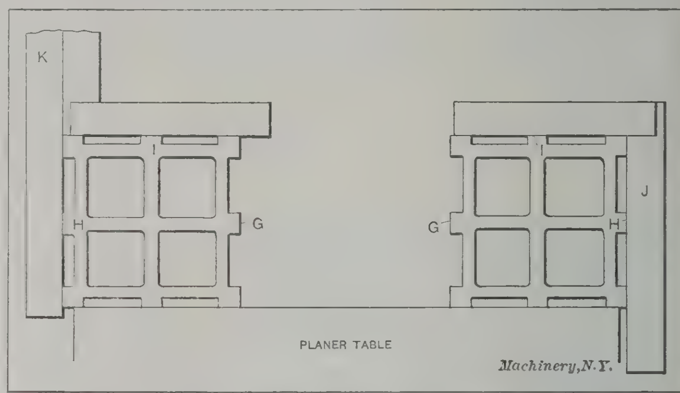


Fig. 11. Method of Testing Accuracy of "Planing Square" when using the Side-heads

the elevating screw nuts are utilized for clamping the jigs by means of bolts D. Endwise location of jig C is determined by matching the end of the cross-rail as shown; then jig C_1 is set by transferring the measurement from the housings by means of the wooden straightedge E. A flat scriber, shown at F and F_1, is used to mark lines on the straightedge which is chalked for this purpose, and when corresponding lines on the jigs coincide with those on the straightedge, jig C_1 is properly set.

When the studs are screwed in place and the back surface of the cross-rail is scraped, the cross-rail is placed in position on the planer and clamped by its gibs. Squaring the cross-rail with the housings is accomplished by holding the bar of a sweep in the angle M, Fig. 1, and applying an indicator to the front housing at N and N_1 (Fig. 1). The low end of the cross-rail is raised a sufficient amount by either moving the teeth in bevel gear O or O_1, as the case may require, in relation to its pinion, or by adjusting one of the nuts on the gear end of the elevating screws, final adjustment being obtained by the latter method. It is always better to raise the low end rather than lower the high end of the cross-rail, on account of the fact that this will take up any lost motion or backlash between the nuts, the feed-screws, and the housings. As the studs have 1/16 inch clearance in the gib, it is necessary to pin the latter after setting the cross-rail.

Final Test and Inspection

With the motors wired up, the belts in place, and the machine thoroughly oiled, the driving works are run for a while before moving the table into mesh with its rack gear, the idea being to prevent possible heating of the bearings by running without load. Next the table is brought into mesh and the bed is again carefully leveled in the same manner as before. When this is accomplished, the ways and tracks are scraped to a bearing, after which the ways are oiled and one or more cuts taken across the table to true it up for the purpose of testing the planer. A straightedge tried on the table crosswise, lengthwise, and across corners, is used to test the truth of the planing.

The side-heads are next tested for "planing square" by the method illustrated in Fig. 11. Two cast iron parallels G are clamped one on each side of the table as shown, and then light cuts are taken down faces H with tools in the side-heads.

Now, with the faces H clamped to the table, cuts are taken down faces I, after which the parallels are turned back to their original positions and a square tried as at J. To "prove" the square, it is used in connection with a straightedge (on the same parallel) as at K, any error detected between the blade of the square and the straightedge showing double the amount of actual error.

The accuracy of setting the cross-rail is now determined by taking a light cut across faces I, using a tool in one of the cross-rail heads, and testing with the square and straightedge as in the previous case. The object in making these tests is a precautionary measure, for by testing the planer under actual working conditions, the accuracy of the tests made during erection are thus proved.

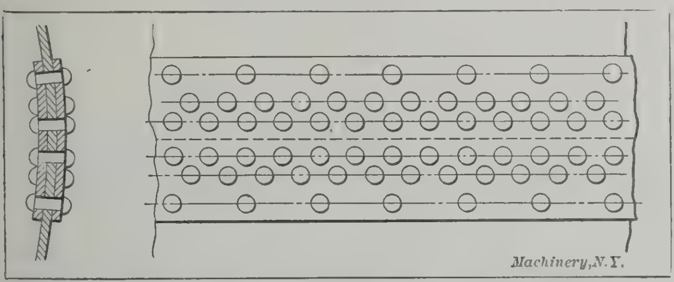
Final inspection includes running the cross-rail to the top of the housings to test the elevating mechanism and ascertain the fact that there is clearance between the cross-rail and arch. All gearing is tested for quiet and smooth running; the fits of all bearing surfaces are inspected; the slides and saddles are run by hand to test the parallelism of their ways and also the ease with which the slides operate, after which the power feed is applied and tested in various ways; the balance of the driving motor armature, and of the fly-wheels and pulleys also, receives careful inspection; in fact, no part is neglected and all errors must be within allowable limits of variation. All tests are made under the personal supervision of an inspector, who enters all data on a form prepared for the purpose, and this report bears the serial number of the planer, and is filed away for future reference.

As opportunity offered during erection, the filling, rubbing down, and priming has progressed, so that after inspection, all that remains to be done is to give the bright parts their final polish, and apply the last coat of paint.

* * *

LONGITUDINAL JOINT FOR BOILERS*

It has been generally accepted in this country that the best form of butted longitudinal riveted joint for boilers is that in which the inside strap is wider than the outside, and has one or more rows of rivets which pass through the shell and the inside strap beyond each edge of the outside strap. The pitch of the first row of outer rivets is double that of the rows that pass through both straps, and if there are other outer rows they may or may not have a still greater pitch. In England, where, until comparatively recently, boiler construction has been superior to ours, this form of joint appears to receive no recognition. It was first devised, as far as known, by Dr. E. D. Leavitt and Edward Kendall, both of Cambridge, Mass., and was first used in 1879 by Mr. Leavitt in some locomotive-type boilers designed by him for the Calumet & Hecla Mining Co. It is, of course, hazardous to state that this joint was never used before, and it is quite possible that it was used in England and discarded.



Recommended Type of Longitudinal Boiler Joint

While every boilermaker has for years been familiar with butt joints, this form made slow progress towards adoption in this country. One form of joint used to avoid the butt joint and get something as good was a lap joint with an inside strap bent at the edge of the lap and riveted on each side of it. This was used on locomotives exclusively, and was of little or no value, as it was simply a somewhat elastic bent tie connecting the two parts of the shell plate. Finally, and fortunately, this joint gave way to the butt joint first described. It has, however, been the author's opinion for some years that a one-sided boiler joint, such as that first described, is also poor construction, and may sooner or later cause a crack in the plate. It is evident that unless the outside rivets fill the holes, they do very little good, and when they do fill them they form an overhung connection and to some extent possess, in themselves, the now recognized defect of the lap joint. Moreover the extended inside plate forms a bent connection between the different rivets at different distances from the center line of the joint.

* Abstract of a paper by Mr. F. W. Dean read before the American Society of Mechanical Engineers, December meeting, 1909.

In many cases designers have placed the outside rivets at a considerable distance from the edge of the outside strap, and this is constantly overdone. It is obvious, on careful thought, that the outside rivets should be as near the edge of the outside strap as practicable, thereby diminishing the bent-tie effect. In order to diminish this effect still further, and also to render the overhung rivets more effective, the inside strap should be thicker than usual, and this feature can hardly be overdone. The inside strap should be at least as thick as the shell plate, and great care should be taken to have the holes match and the rivets fill the holes.

When a joint of this kind is tested to destruction in a testing machine, it will be found to fail somewhat in detail, the inside strap bending slightly and the outside rivets being the last to rupture after yielding a little. In a boiler the joint would be weaker than a flat specimen on account of the bent-tie feature. This could be prevented if it were practicable to calk the inside strap as it would thereby be compelled to maintain the circular form. The theoretical efficiency of this joint is greater than of any other kind, but in practice the efficiency is not realized.

In order to avoid the defects of the one-sided butt joint, the author has adopted a joint with both straps of the same width, as illustrated in the accompanying engraving. This has the merit of having all rivets in double shear and the strains all taken care of in the best manner. The efficiency of this joint can hardly be above 84 or 85 per cent, while that of the one-sided joint can be theoretically 91 or 92 per cent; but the certainty that the efficiency of the former is realized in practice is ample compensation for the use of slightly thicker plates. The pitch of the outer rows of rivets is rather great, compelling the use of a thick outside strap in order to stand calking and remain steam-tight. An equally thick inside strap is used in order to diminish the bent-tie effect. This effect is small, however, as the rivets are all near the center of the joint. It can be eliminated by calking the inside strap, which is practicable with this joint, and is done in the best marine practice.

* * *

The manner in which samples of air at high altitudes are collected shows an interesting example of the methods employed by scientists for ascertaining facts which cannot be obtained by direct personal investigation. Samples of air at a height of nearly nine miles have recently been obtained and examined for the purpose of ascertaining the presence of rare gases. The collecting apparatus is carried by a large balloon and consists of a number of vacuum tubes, each drawn out to a very fine point at one end. At the desired height, an electromagnetic device connected with each tube, and operated by a barometer, breaks off the point of the tube, thus admitting the air. Within a few moments a second contact sends current through a platinum wire around the broken end, thereby melting the glass and sealing the tube. The samples thus obtained have shown the presence of argon and neon, but no helium was found in air above an altitude of six miles.

* * *

High speed steel has made a great improvement possible in the speed of threading dies on bolt machines. At the Atlantic City conventions of the Master Mechanics and Master Car Builders' Associations, the Landis Machine Co. exhibited a bolt threader equipped with a Landis high speed die, working at a cutting speed of from 45 to 55 lineal feet per minute. Rough bolts were threaded with startling rapidity, a two-spindle machine keeping a man busily employed all the time when threading ⅝-inch bolts with, say, 1¼ inch of thread. The actual time required for cutting the thread of this size and length was only about three seconds.

SHOP PHOTOGRAPHY*

R. F. KIEFER†

The writer has read with interest several articles on shop photography which have, from time to time, appeared in MACHINERY. However, some of these articles disagree, to some extent, and are not as complete as they might have been. This prompts the writer to describe the methods used by him during a ten year's experience in the taking of pictures. When these methods are carefully followed, there is practically no excuse for failure or for poor pictures.

The Camera

For general shop work a double extension camera, equipped with rising, falling and sliding front, swing and reversible back, is recommended. It should be fitted with a level. A small T-level, such as can be obtained for twenty-five cents, is preferable. The best size of camera is 5 × 7 inches. Anything larger is more or less cumbersome and heavy, and if pictures larger than 5 × 7 inches are required, it is a comparatively simple matter to enlarge them. On the other hand, cameras smaller than 5 × 7 inches are apt to require the enlarging of many pictures, and this, of course, would be too expensive. While the best lens is none too good, an anastigmat working at F 5.5 is as fast and good as ordinarily will be required. An automatic shutter is desirable. As regards plates, pictures can be taken rapidly on "fast" plates; the writer is now using a plate which requires only one-quarter to one-third the length of exposure required with the ordinary plate.

TABLE I. TIME OF EXPOSURE FOR DIFFERENT LIGHT FACTORS

Interiors; Dark-colored Objects

Lens Diaphragm		10 sec.	15 sec.	20 sec.	25 sec.	30 sec.	35 sec.	40 sec.	45 sec.	50 sec.	1 min	1¼ min.	1½ min.	2 min.	2½ min.	3 min.	3½ min.	4 min.	5 min.	6 min.	8 min.	10 min	12 min.	15 min.	20 min.	30 min.
F- 5*	2†	⅗	⅘	1⅕	1½	1¾	2¼	2⅜	2½	3	3¾	4½	5	7½	8½	10	12	15	18	20	30	38	45	48	1⅕	1¾
F- 8	4	1⅕	1¾	2½	3	3¾	4½	4¾	5	6	7½	9	10	15	18	20	25	30	38	45	1	1¼	1½	1½	2½	3¾
F-11	8	2½	3¾	5	6½	7½	9	9½	10	13	15	18	20	30	38	45	52	1	1¼	1½	2	2½	3	3¾	5	7½
F-16	16	5	7½	10	12½	15	18	20	20	25	30	36	45	1	1¼	1½	1¾	2	2½	3	4	5	6	7½	10	15
F-22	32	10	15	20	25	30	36	45	45	50	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	15	20	30
F-32	64	20	30	45	52	1	1¼	1½	1½	1¾	2	2½	3	4	5	6	7	8	10	12	16	20	24	30	45	60
F-45	128	45	1	1½	1¾	2	2½	3	3	3½	4	5	6	8	10	12	14	16	20	24	32	40	48	60	90	120
F-64	256	1½	2	3	3½	4	5	6	6	7	8	10	12	16	20	24	28	32	40	48	60	80	96	120	180	240

* British system. † United States System. Figures beneath heavy lines signify minutes; those above, seconds

fan can be placed in a ventilator and used as an exhaust fan. This is a satisfactory and economical arrangement. Cold, running water is essential, and hot water desirable, this latter because trays, graduates, etc., can be quickly washed with hot water, and will be perfectly clean, especially if a few drops of sulphuric acid be added to the water and the utensils left to soak a few minutes. They are then thoroughly rinsed with cold water. If this is frequently done, it will save many pictures which might otherwise be spotted, streaked or stained.

Halation

Halation, which spoils many otherwise good negatives, can be intelligently guarded against. The writer disagrees with a previous contributor who says that "negatives entirely free from halation are as easily and truly made upon glass plates as upon films." This is true only if the glass plate is specified as "non-halation."

In photographs of interiors, the strongest high-lights, such as the windows, or the brilliant polished portions of machinery which in some cases reflect light sufficiently to cause the same results, are almost always blurred at the edges. This is due to halation, or reflection from the inner surface of the glass. When we consider the difference in thickness of a glass plate and film, we can readily understand why films show less halation than glass plates.

In order to overcome halation when using glass plates, it is necessary either to use non-halation plates, or, if they cannot be procured, exceptional care must be used when employing ordinary glass plates. The article in the engineering edition of MACHINERY, January, 1909, entitled "Industrial Photography" gives some good hints in regard to the avoidance of halation when using glass plates. The covering up of windows, for instance, is there mentioned.

TABLE II. TIME OF EXPOSURE FOR DIFFERENT LIGHT FACTORS

Interiors; Objects of Average Colors

Lens Diaphragm		10 sec.	15 sec.	20 sec.	25 sec.	30 sec.	35 sec.	40 sec.	45 sec.	50 sec.	1 min.	1¼ min.	1½ min.	2 min.	2½ min.	3 min.	3½ min.	4 min.	5 min.	6 min	8 min.	10 min.	12 min.	15 min.	20 min.	30 min.
F- 5	2	⅖	⅗	⅘	1	1⅕	1¼	1½	1¾	2	2⅖	3¼	3¾	5	6¼	7½	9	10	13	15	20	26	30	36	48	1⅕
F- 8	4	9/10	1⅕	1¾	2	2⅖	3	3½	3¾	4	5	6½	7½	10	12½	15	18	20	25	30	45	52	1	1⅕	1¾	2½
F-11	8	1¾	2⅖	3¾	4¼	5	6	7½	7½	9	10	13	15	20	25	30	38	45	52	1	1½	1¾	2	2½	3¾	5
F-16	16	3¾	5	7½	9	10	13	15	15	18	20	25	30	45	52	1	1¼	1½	1¾	2	3	3½	4	5	7½	10
F-22	32	7½	10	15	18	20	25	30	30	40	45	50	1	1½	1¾	2	2½	3	3½	4	6	7	8	10	15	20
F-32	64	15	20	30	36	45	50	1	1	1¼	1½	1¾	2	3	3½	4	5	6	7	8	12	14	16	20	30	45
F-45	128	30	45	1	1¼	1½	1¾	2	2	2½	3	3½	4	6	7	8	10	12	14	16	24	28	32	45	60	90
F-64	256	1	1½	2	2½	3	3½	4	4	5	6	7	8	12	14	16	20	24	28	32	48	56	64	90	120	180

Figures beneath heavy lines signify minutes; those above, seconds.

The Dark-room

The dark-room is not usually given the consideration which it requires, and this is a fruitful cause of poor pictures. The dark-room should be of ample size to permit working without being cramped for room. It should have red or ruby light for ordinary dark-room work, and opportunity for daylight for printing. Good ventilation is also important, because it is just as difficult to do good work at an excessive temperature in the dark-room as anywhere else. An ordinary desk

It might not be out of place to mention here that in few, if any, shops are the windows kept as clean as they might be, and this fact alone is often of advantage. This is the only place in photography where dirt in any shape is desirable. Even with dirty windows, however, a picture should not be taken with the camera pointing directly toward the light. If a machine, for instance, is placed on the east side of the building, and we must take our picture from the west side, the picture should not be taken in the morning but rather in the late afternoon, at which time the light will be strongest behind the camera, and a much better picture will result. Furthermore, if choice of time is possible, take the picture when

* The following articles relating to shop photography and kindred subjects have previously been published in MACHINERY: Shop Photography, November, 1906; Photographing Drawings, April, 1907; Photographs for Illustration, September, 1907; Photographing Drawings, October, 1907, engineering edition; Shop Photography, December, 1907; Vertical Camera Bracket, February, 1908; Correcting Perspective in Shop Photography, February, 1908; Shop Photography, December, 1908; Industrial Photography, January, 1909, engineering edition; Shop Photography, February, 1909; Universal Camera Bracket, April, 1909.

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the light is the softest or most even, so that the harsh contrasts which are apt to give the soot and whitewashed effects, are avoided. A reasonably soft light, long exposure with small diaphragm, and careful development, will give much better results than strong light, short exposure, and large diaphragm.

The operation of placing the dry plates in the plate holders is usually spoken of as "loading" the holder. Attention should be called to the advisability of cleaning the plate at this time. A soft camel's hair brush should be kept for this purpose only, and all plates should be carefully dusted before closing the slide, so as to remove all particles of dust which would

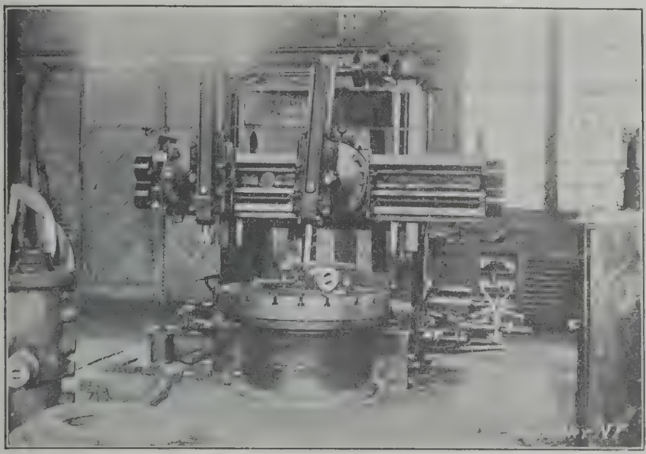

Fig. 1. Photograph taken 4.45 P. M. Diaphragm No. 32, Exposure 45 Seconds. Camera pointed toward the Light

cause spots in the finished picture. The plate holder as well as the slides should also be thoroughly dusted.

Focusing

In shop photography a different result is required than in portrait work, where "softness" is wanted. In machine photographs sharp lines are required. It is advisable to focus with the diaphragm set at No. 4, and after the image is as sharp and clear as possible, adjust to No. 16 or No. 32. This will give a much clearer picture and is well worth the extra length of exposure.

Exposure

A realization of the relation between the light, exposure and development, only comes to the photographer by experience and by a study of his prints. Correct exposure is only a relative term. Approximately correct is about as near as one can get to proper exposure in shop work. Experience and a certain amount of judgment enter into the decision as to the correct length of time. The exposure tables accompanying

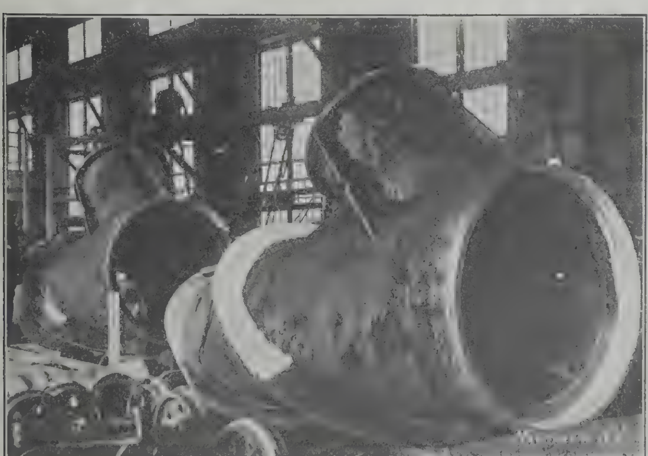

Fig. 2. Photograph taken 4.55 P. M. Diaphragm 64, Exposure 2 minutes. Camera not pointed directly toward the Light

this article will, therefore, be found convenient, and if the directions for their use, given in the following, are faithfully followed, very few pictures will be spoiled on account of improper exposure. It is, of course, desirable that the length of exposure be as near correct as possible, as this will tend to make the general average of the results better.

The method the writer uses in arriving at the decision in regard to the length of time for exposure is as follows: Take a fresh strip of standard "printing-out" paper—"Disco," manufactured by the Defender Photo Supply Co., "Solio," manufactured by the Eastman Co., or "Actinos," manufactured by the Lumiere N. A. Co.—and fold it over so that it covers itself in a way to expose only a small portion to the light. This paper should be kept covered until we are ready to take the photograph. Then hold the paper as nearly as possible where the average intensity of light strikes the machine. Uncover it and note the time required for discoloring the exposed portion of the paper so that it just presents a plainly discernible difference from the unexposed portion. This may require anywhere from two or three seconds to half an hour, depending, of course, upon the intensity of the light. In a medium light, from ten to forty seconds will suffice. This length of time is now our "time factor," and by referring to the accompanying exposure tables, it is easy to see what use is to be made of it.

The photograph shown in Fig. 1 was taken at 4.45 in the afternoon, and some halation can be noticed, but this can be overcome to a certain extent by printing the picture somewhat longer. In so doing, however, more or less detail will be lost. Solio paper was used to determine the light factor, which was forty-five seconds; diaphragm No. 32, U. S. system, was used. The machine photographed was painted with the ordinary black color of machine tools; therefore, the required length of exposure is found in Table 1, for dark-colored objects, in the column headed "45 seconds" and in the line denoted "F 22 Diaphragm 32" in the left-hand column. The required time of exposure thus is found to be forty-five seconds.

When the photograph, Fig. 2, was taken, "Disco" paper was used to determine the light factor, which in this case was one

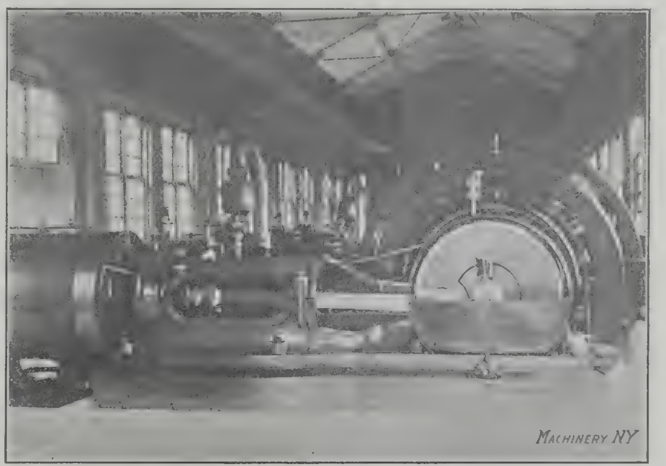

Fig. 3. A Picture taken on a Stormy Day, 11 A. M., with the Plate Reversed in the Holder, thus Reversing the Picture, but Avoiding Halation

minute. No. 64 diaphragm was used, and the length of the exposure was determined from the table in the same way as in Fig. 1, the time required being two minutes, as found in the vertical column headed "one minute" and in the horizontal line denoted "F 32 diaphragm 64." Comparing Figs. 1 and 2 a great difference is noticeable in regard to the tendency toward halation. Fig. 2 was exposed at 4.55 P. M., just ten minutes later than Fig. 1, both pictures being taken in the same shop on the same day. Fig. 1, however, was taken with the camera pointing directly toward the windows, while in Fig. 2 the windows are in a diagonal direction from the camera, this being the cause of the difference. In Fig. 2 the windows at the extreme left are very clear and distinct, while that toward the right, more nearly in front of the camera, shows a very distinct halation. This experiment proves conclusively the advantage of avoiding pointing the camera directly toward the light.

Fig. 3 was taken about eleven o'clock A. M., the sun shining very brightly. While this negative is fully timed there is practically no tendency toward halation. All these pictures were taken on plates. The reason that no halation is shown in Fig. 3, however, is disclosed by looking at the name-plate of the generator, which is reversed, or shows as it would in a mirror. This picture was taken "through the glass," that is, the plate was put into the plate-holder with the glass side out, which, of course, is the reverse of the usual method.

This, however, bears out the explanation of halation as being governed by the thickness of the glass plate. The same view taken two minutes later with the camera in the same place with the same length of exposure and the same diaphragm, but with the plate in the holder in the usual way was very badly affected by halation. A non-halation plate would, of course, in this case do away with the difficulty.

The exposure tables (Tables I and II) are intended for the following brands of plates and films: Ansco Film; Cramer Crown; Cramer Instantaneous Iso; Cramer Tri; Defender King Eastman Film; Eastman Extra Rapid; Forbes Instantaneous; Hammer; Kodoid; Lumiere Blue Label; Lumiere Ortho A; Lumiere Ortho B; Lumiere Panchro C; Lumiere Non-Halation Simplex Ortho A; Monarch; Pacific; Premo Film Pack; Record; R. O. C.; Seed 27; Standard Imp.; Standard Ex.

Lumiere New (Sigma) Σ and Lumiere Non-Halation Simplex (Sigma) Σ require but one quarter the time specified in the tables.

Seed 26 x; Cramer Banner; Hammer Non-Halation; and Hammer Fast, require about one-half longer exposure than the tables call for.

Development

Assume that the plate has been exposed and that we are now back in the dark-room, ready to develop the plate. Before doing so, dust the plate again carefully with a camel's hair brush to remove any particles of dust that may have settled upon the plate when the slide was reversed after the exposure. Almost any developing agent will make a picture on a properly exposed negative, yet the writer has found it advisable to use a developer such as recommended by the manufacturer of the plate used. The development is a comparatively simple operation if undertaken in the proper manner. The most desirable color in a negative is a warm black, with possibly a slight tint of yellow through the image. The development should be carried only to the point where the highest lights are of a sufficient transparency to print details. This kind of negative prints quickly, and will be found the most satisfactory for printing on any class of paper. The temperature of the developer should never be allowed to rise above 70 degrees F. or fall below 65 degrees F. An all-glass dairy or bath thermometer, which can be purchased for about thirty cents, is very necessary for all dark-rooms. A too-cool developer produces thin negatives which have the appearance of being under-exposed. A too-warm developer, on the other hand, produces a heavy flat appearance in the negatives.

Table III, for which the writer is indebted to the M. A. Seed Dry Plate Co., gives the proportions of various developers. The numbers in the column headed "Factor" may require some explanation. The "factoral" system of development is a desirable one to use, exceedingly simple in its application, and insures the bringing out of everything that is in the negative. This system is based on the fact that no matter what the exposure, the development proceeds at the regular rate, and the time elapsing from the moment when the plate is placed in the developing solution until the appearance of the first high-lights of the image is a certain proportion of the total time required for the development. Suppose we are using Dianol developer, the factor of which is 18. The first high-lights appear twenty seconds after the plate has been placed in the solution. Then 18 × 20 seconds or 6 minutes total time is required for the complete development. When developed, the plate is removed from the developer, rinsed in fresh water and placed in the fixing bath.

A number of formulas for other common developing solutions with their factors are given below:

Pyro—Developing Factor 12

A. Pure water, 16 oz.; pyro, 1 oz.; oxalic acid, 10 gr.

B. Pure water, 16 oz.; sulphite of soda, 2 oz.

C. Pure water, 16 oz.; carbonate of soda, 2 oz.

To make the developing solution, use one ounce each of the solutions A, B and C, and add seven ounces pure water.

Eikonogen Hydrochinon—Developing Factor 12

A. Pure water, 48 oz.; sulphite of soda, 2 oz.; eikonogen, 240 gr.; hydrochinon, 60 gr.

(For more contrast, the quantity of water in the solution may be reduced to 32 ounces. Use boiling water. In cold weather a little glycerine will prevent precipitation.)

B. Pure water, 16 oz.; carbonate of soda, 2 oz.

To make the developing solution, use three ounces of solution A and one ounce of solution B.

Metol-hydrochinon—Developing Factor 15

A. Pure water, 64 oz.; metol, 120 gr.; hydrochinon, 120 gr.; sulphite of soda, 2 oz.

(Dissolve in the order given. Metol, to prevent precipitation, should always be dissolved in water before the sulphite is added.)

B. Pure water, 16 oz.; carbonate of soda, 2 oz.

TABLE III. DEVELOPERS WITH VARIOUS AGENTS

	A			B			Use			
	Pure Water	Seed's Sulphite	Developing Agent	Pure Water	Seed's Carbonate	Potassium Bromide	A	B	Pure Water	Factor
	oz.	oz.	gr.	oz.	oz.	gr.	oz.	oz.	oz.	
Metol*	16	1	120	8	1	..	4	1	5	25
Eikonogen	24	1	150	16	1	..	3	1	..	10
Hydrochinon**	16	1	160	16	2	80	1	1	..	4
Edinol	16	2	80	8	1	..	2	1	..	12
Tolidol	16	1	160	16	1	..	1	1	2	7
Glycin**	32	1	320	48	6	..	2	3	..	8
Imogen	16	1	240	24	3	..	2	3	..	7
Dianol	32	½	40	..	..	..	..	..	..	18
Amidol	24	½	40	No alkali needed					..	30
Rodinal		To ¼ oz. add 10 oz. water							..	30

* Dissolve metol in water before adding sulphite.

** For hydrochinon and glycin use potassium carbonate and dissolve glycin in hot water. Hydrochinon is a contrast formula for over-exposed plates and for black and white line work. It is not suitable for ordinary use.

If crystal sodas are used, add 15 grains of bromide of potassium to 16 ounces of solution B.

To make the developing solution, use four ounces of solution A, one ounce of solution B, and four ounces of pure water.

Acid Fixing Bath

A. Pure water, 96 oz.; hypo, 2 pounds; C. P. sulphite of soda, 2 oz.

B. Pure water, 32 oz.; chrome alum, 2 oz.; C. P. sulphuric acid, ¼ oz.

See that the chemicals are entirely dissolved, and then pour solution B into A slowly while stirring A rapidly.

Clearing Solution for Pyro Stains

Iron sulphate, 3 oz.; water, 16 oz.; sulphuric acid, ¼ oz.; alum, 1 oz.

Fixing

The fixing of a plate after development is so simple a matter that it is hardly necessary to more than advise the use of an acid-hypo fixing solution for plates, especially in the summer time, in place of the ordinary plain fixing bath. The plates should remain in the hypo bath for ten minutes after all white has dissolved from the reverse side of the negative. Then it should be well washed, say for one hour, preferably in running water.

Before allowing the plates to dry, the film side should be gently and carefully wiped with a wad of absorbent cotton to remove any "specks" which may be on the negative. This is very important, particularly when the water is very hard, as the film side collects a sediment when having been washed for some time, and if it is not removed before the negative is dry, it makes it unfit for printing. After having wiped the surface of the plate, rinse it thoroughly, and set it to dry in a ventilated place free from dust.

Negatives, when drying, should always be so placed that a current of air can pass around, over, and between them. The warmer this current of air is, the more intense the negative will be, and *vice versa.* Never change the location or position of a negative during the time it is drying, as marks and spots are almost sure to appear, owing to the fact that different conditions of air produce a difference in the intensity of the negative.

HARDENING CARBON STEELS*

H. RALPH BADGER†

Originally the name steel was applied to various combinations of iron and carbon, there being present, together with these, as impurities, small proportions of silicon and manganese. At the present time, however, the use of the name is extended to cover combinations of iron with tungsten, vanadium, nickel, chromium, molybdenum, titanium and some of the rarer elements. These latter combinations are quite generally known as the *alloy* steels to distinguish them from the *carbon* steels, in which latter the characteristic properties are dependent upon the presence of carbon alone. The alloy steels are divided into the high-speed steels and the Mushet or air-hardening steels. The specific properties that distinguish these different steels are due in part to their respective compositions, that is, to the particular elements they contain, and, in part, to their subsequent working and heat treatment.

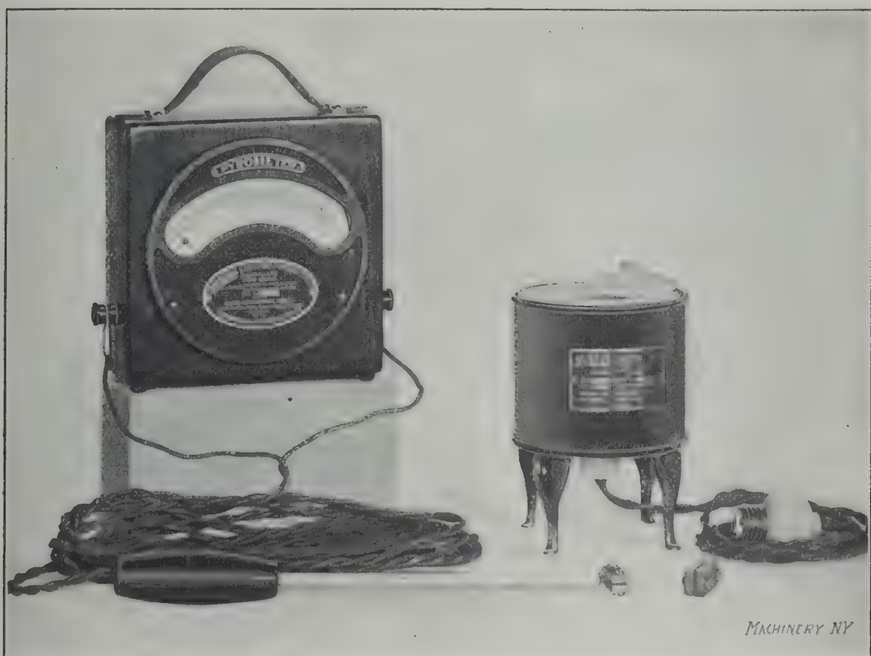

Fig. 1. Hoskins Electric Heating Furnace and Pyrometer used for ascertaining the Decalescence and Recalescence Points of Steel

Effect of Difference in Composition of Steel

In general, any change in the composition of a steel results in some change in its properties. For example, the addition of certain metallic elements to a carbon steel causes, in the alloy steel thus formed, a change in position of the proper hardening temperature point. Tungsten or manganese tend to lower this point, boron and vanadium to raise it; the amount of the change is practically proportional to the amount of the element added. Just as a small proportion of carbon added to iron produces steel which has decidedly different properties than those found in pure iron, so increasing the proportion of carbon in the steel thus formed, within certain limits, causes a variation in the degree in which these properties manifest themselves. For example, consider the property of tensile strength. In a "ten-point" carbon steel (one in which there is present but 0.1 per cent of carbon) the tensile strength is very nearly 25 per cent greater than that of pure iron. Adding more carbon causes the tensile strength to rise, approximately, at the rate of 2.5 per cent for each 0.01 per cent of carbon added.

Carbon steels are divided into three classes according to the proportion of carbon which they contain. The first of these embraces the "unsaturated" steels, in which the carbon content is lower than 0.89 per cent; the second, the "saturated" steels, in which the proportion of carbon is exactly 0.89 per cent; and, the third, the "supersaturated" steels, in which the carbon content is higher than 0.89 per cent.

Effect of Heat Treatment

With a steel of a given composition, proper heat treatments may be applied which, of themselves, will first alter in form or degree some of its specific properties, or second, practically eliminate one or more of these, or third, add certain new ones. Physical properties of size, shape and ductility are examples of the first case; an example of the second case is found in the heating of steel beyond its hardening temperature, which takes away its magnetism, making it non-magnetic; and an example if the third case is the fact that a greater degree of hardness may be added to steel by the process of hardening. In this connection it must be understood that, strictly speaking, hardness is a relative term and all steel has some hardness.

There are three general heat treatment operations, so considered; forging, hardening—with which this article will deal—and tempering. In all of these the object sought is to change in some manner the existing properties of the steel; in other words, to produce in it certain permanent conditions.

The controlling factor in all heat treatment is temperature. Whether the operation is forging, hardening or tempering, there is for any certain steel and particular use thereof a definite temperature point that alone gives the best results in working it. Insufficient temperatures do not produce the results sought. Excessive temperatures, either through ignorance of what the correct point is, or through inability to tell when it exists, cause "burned" steel; this is a common failing, resulting in great loss. Very slight variations from the proper temperature may do irreparable damage.

Due to temperature variation alone, carbon steel may be had in any of three conditions: first, in the unhardened or annealed state, when not heated to temperatures above 1,350 degrees F.; second, in the hardened state, by heating to temperatures between 1,350 and 1,500 degrees F.; third, in a state softer than the second though harder than the first, when heated to temperatures which exceed 1,500 degrees F.

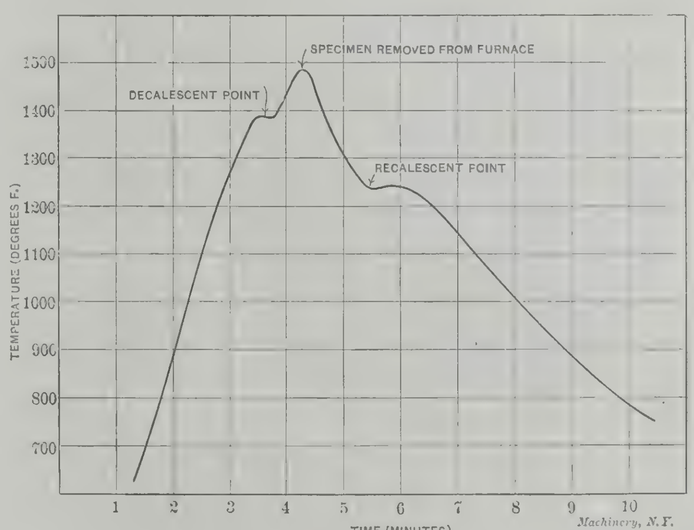

Fig. 2. Diagram showing the Relation between Time and Temperature when heating Steel, and the Critical Temperatures of One-point Carbon Steel

The Hardening Process

The hardening of a carbon steel is the result of a change of internal structure which takes place in the steel when heated properly to a correct temperature. In the different carbon steels this change, for practical purposes, is effective only in those in which the proportion of carbon is between 0.2 per

* For additional information on this and kindred subjects see the following articles previously published in MACHINERY: Steel and its Treatment, September, October, November and December, 1902, and January, 1903; Pyrometers with Special Reference to the Morse Heat Gage, February, 1904, engineering edition; A New Hardening Furnace, January, 1905, engineering edition; Hardening without Cracking, February, 1906; Method of Hardening Thin Milling Cutters, July, 1907; The Gaging of Heats for Hardening, April, 1908; Indicator for Ascertaining Hardening Temperatures, June, 1908, engineering edition; Local Hardening and Tempering, August, 1908; A Modern Steel Hardening Plant, November, 1908; Temper Colors and Temperatures and Colors for Hardening, December, 1908; Westmacott Hardening and Annealing Furnace, March, 1909; The Heat Treatment of Steel, April, 1909; Leeds and Northrup Hardening and Annealing Pyrometer, June, 1909; and Recalescence and its Relation to Hardening, October, 1909.

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cent and 2.0 per cent, that is, between "twenty-point" and "two" carbon steels, respectively.

When heated, ordinary carbon steels begin to soften at about 390 degrees F. and continue to soften throughout a range of 310 degrees F. At the point 700 degrees F. practically all of the hardness has disappeared. "Red hardness" in a steel is a property which enables it to remain hard at red heat. In a high-speed steel this property is of the first importance, 1,020 degrees F. being a minimum temperature at which softening may begin. This is some 630 degrees F. above the point at which softening commences in ordinary carbon steels.

The process of hardening a steel is best carried out in a closed furnace. Of the many sources of energy capable of producing the required heat, electricity offers the most attractive advantages. The electric resistance furnace, as now built in a variety of sizes of either muffle or tube chamber types, has one fundamental point of superiority over all coal, coke, gas, or oil-heated furnaces. It is entirely free from all products of combustion, the heat being produced by electrical resistance. This is important. It does away with the chief cause of oxidation of the heated steel. Further, the temperature of the electric furnaces can be easily and accurately regulated to, and maintained uniform at, any desired point. When electric power is generated for other purposes, the increased cost of this form of energy for operating furnaces is not sufficient to argue against it. Even when the current is purchased, the superior quality of work performed by this kind of furnace frequently more than offsets the slightly higher cost of operation.

In the actual heating of a piece of steel, several requirements are essential to good hardening: first, that small projections or cutting edges are not heated more rapidly than is the body of the piece, that is, that all parts are heated at the same rate, and second, that all parts are heated to the same temperature. These conditions are facilitated by slow heating, especially when the heated piece is large. A uniform heat, as low in temperature as will give the required hardness, produces the best product. Lack of uniformity in heating causes irregular grain and internal strains, and may even produce surface cracks. Any temperature above the "critical point" of steel tends to open its grain—to make it coarse and to diminish its strength—though such a temperature may not be sufficient to lessen appreciably its hardness.

Critical Temperatures

The temperatures at which take place the previously mentioned internal changes in the structure of a steel are frequently spoken of as the "critical points." These are different in steels of different carbon contents. The higher the percentage of carbon present, the lower the temperature required to produce the internal change. In other words, the critical points of a high carbon steel are lower than those of a low carbon steel. In steels of the commonly used carbon contents, there are two of these critical temperatures, called the *decalescence* point and the *recalescence* point, respectively.

The decalescence point of any steel marks the correct hardening temperature of that particular steel. It occurs while the temperature of the steel is rising. The piece is ready to be removed from the source of heat directly after it has been heated uniformly to this temperature, for then the structural change necessary to produce hardness has been completed. Heating the piece slightly more may be desirable for either or both of the two following reasons. First, in case the piece has been heated too quickly, that is, not uniformly, this excess temperature will assure the structural change being complete throughout the piece. Second, any slight loss of heat which may take place in transferring the piece from the furnace to the quenching bath may thus be allowed for, leaving the piece at the proper temperature when quenched.

If a piece of steel which has been heated above its decalescence point be allowed to cool slowly, it will pass through a structural change, the reverse of that which takes place on a rising temperature. The point at which this takes place is the recalescence point and is lower than the rising critical temperature by some 85 to 215 degrees. The location of these points is made evident by the fact that while passing through them the temperature of the steel remains stationary for an appreciable length of time. It is well to observe that the lower of

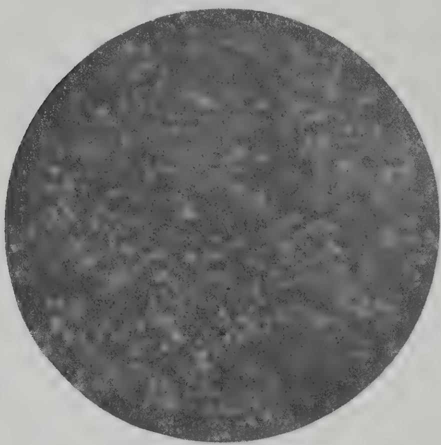


Fig. 3. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1900 Degrees F.

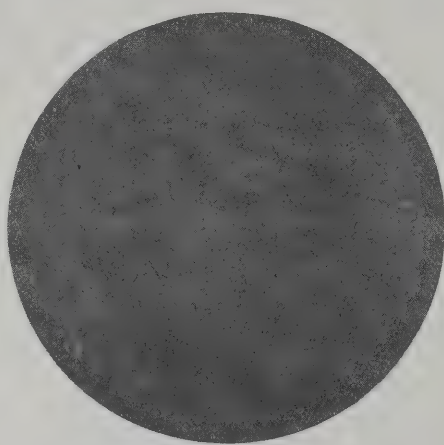


Fig. 4. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1750 Degrees F.

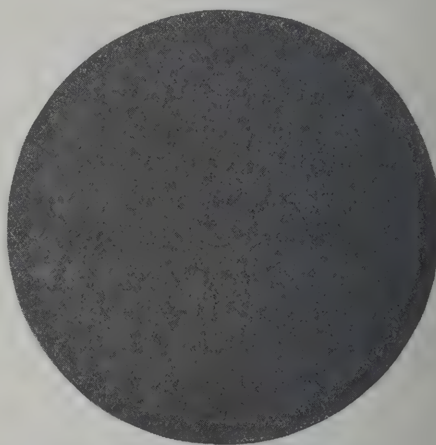


Fig. 5. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1600 Degrees F.

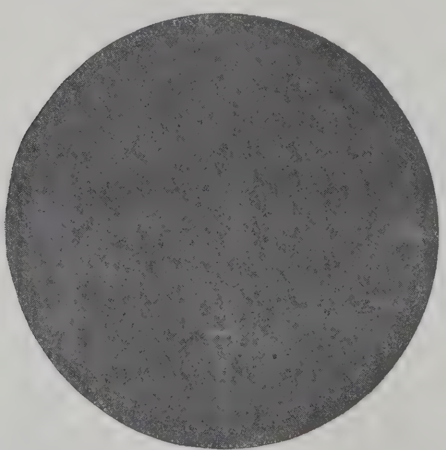


Fig. 6. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1510 Degrees F.

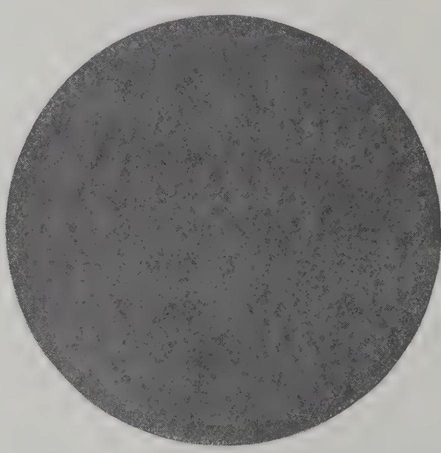


Fig. 7. Micro-photograph (Magnified 45 Diameters) of Steel Quenched at 1425 Degrees F.

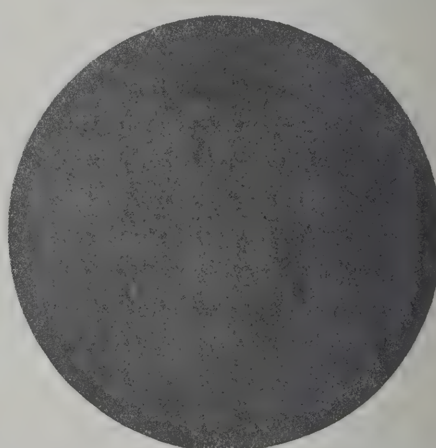


Fig. 8. Micro-photograph (Magnified 22 Diameters) of Steel Quenched at 1385 Degrees F., or 5 Degrees above the Decalescence Point

these points does not manifest itself unless the higher one has been first fully passed. As these critical points are different for different steels, they cannot be definitely known for any particular steel without an actual determination. While heating a piece of steel to its correct hardening temperature produces a change in its structure which makes possible an increase in its hardness, this condition is only temporary unless the piece is quenched.

Quenching

The quenching consists in plunging the heated steel into a bath, cooling it quickly. By this operation the structural change seems to be "trapped" and permanently set. Were it possible to make this cooling instantaneous and uniform throughout the piece, it would be perfectly and symmetrically hardened. This condition cannot, however, be realized, as the rate of cooling is affected both by the size and shape of the treated piece; the bulkier the piece, the larger the amount of heat that must be transferred to the surface and there dissipated through the cooling bath; the smaller the exposed surface in comparison with the bulk, the longer will be the time required for cooling. Remembering that the cooling should be as quickly accomplished as possible, the bath should be amply large to dissipate the heat rapidly and uniformly. Too small a quenching bath will cause much loss, due to the resulting irregular and slow cooling. To insure uniformly quenched products, the temperature of the bath should be kept constant, so that successive pieces immersed in it will be acted upon by the same quenching temperature. Running water is a satisfactory means of producing this condition.

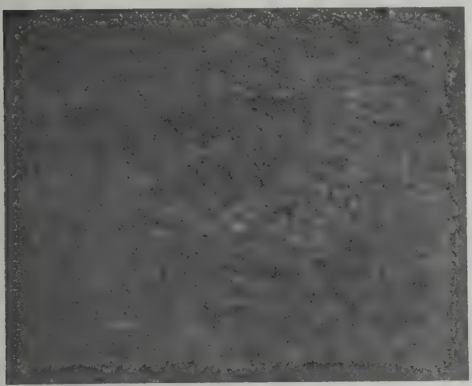


Fig. 9. Micro-photograph of Steel Quenched at 1380 Degrees F. or when just reaching the Decalescence Point

The composition of the quenching bath may vary for different purposes, water, oil or brine being used. Greater hardness is obtained from quenching, at the same temperature, in salt brine and less in oil, than is obtained by quenching in water. This is due to a difference in the heat-dissipating power possessed by these substances. Quenching thin and complicated pieces in salt brine is unsafe as there is danger of the piece cracking, due to the extreme suddenness of cooling thus produced.

In actual shop work the steel to be hardened is generally of a variety of sizes, shapes and compositions. To obtain uniformity both of heating and of cooling, as well as the correct limiting temperature, the peculiarities of each piece must be given consideration in accordance with the points outlined above. In other words, to harden all pieces in a manner best adapted to but one piece would result in inferior quality and possible loss of all except this one. Each different piece must be treated individually in a way calculated to bring out the best results from it.

Theory of Critical Points

The presence of the critical points in the heating and cooling of a piece of steel is a phenomenon. The most reasonable explanation is as follows:

While heating, the steel uniformly absorbs heat. Up to the decalescence point all of the energy of this heat is exerted in raising the temperature of the piece. At this point, the heat taken on by the steel is expended, not in raising the temperature of the piece, but in work which produces the internal changes here taking place between the carbon and the iron. Hence, when the heat added is used in this manner, the temperature of the piece, having nothing to increase it, remains stationary, or, owing to surface radiation, may even fall slightly. After the change is complete, the added heat is again expended in raising the temperature of the piece, which increases proportionally.

When the piece has been heated above the decalescence point and allowed to cool slowly, the process is reversed. Heat is then radiated from the piece. Until the recalescence point is reached, the temperature falls uniformly. Here the internal relation of the carbon and iron is transformed to its original condition, the work required to do this being converted into heat. This heat, set free in the steel, supplies, for the moment, the equivalent of that being radiated from the surface, and the temperature of the piece ceases falling and remains stationary. Should the heat resulting from the internal changes be greater than that of surface radiation, the resulting temperature of the piece will not only cease falling but will obviously rise slightly at this point. In either event the condition exists only momentarily, but when the carbon and iron constituents have resumed their original relation, the internal heating ceases, and the temperature of the piece falls steadily, due to surface radiation.

Apparatus for Determining the Critical Point

From the foregoing sections it is evident, first, that there is a definite temperature at which any carbon steel should be hardened, and, second, that there results great loss, both of labor and material, unless the hardening is carried out at this temperature. The actual shop problem thus presented is to determine readily and accurately the correct hardening temperature for any carbon steel that may be in use. This can be done by the use of various types of pyrometers; the apparatus illustrated in Fig. 1, which is made by the Hoskins Mfg. Co., of Detroit, Mich., is well adapted for the purpose. This apparatus consists of a small electric furnace in which to heat a specimen of the steel to be tested, and a special thermo-couple pyrometer for indicating the temperature of this specimen throughout its range of heating. The specimen itself should be properly shaped for clamping to the thermo-couple.

The furnace may be operated on either alternating or direct current circuits. The furnace chamber is 2 1/16 inches in diameter and 2½ inches deep. Heat is produced by means of the resistance offered to the passage of an electric current through the "resistor" or heating element which in the form of wire is wound in close contact with the chamber lining. The furnace is designed so that it can be used on standard lighting circuits to which ready connection is made with a twin conductor cord and lamp plug. In operation, it consumes 3½ amperes at 110 volts, and is capable of producing a chamber temperature of 1,830 degrees F., which is considerably higher than required for a carbon steel.

The pyrometer consists of a thermo-couple, connecting leads and indicating meter. The thermo-couple is of small wire so as to respond quickly to any slight variation in temperature. The welded end of this couple is slightly flattened to enable a good contact between it and the steel specimen. The meter is portable and indicates temperatures up to 2,552 degrees F.

The specimen of the steel to be tested should be small, so as to heat quickly and uniformly. A well-formed specimen is made with two duplicate parts, each 1¼ inch long x ½ inch wide x ¼ inch thick. The pieces are clamped by means of two ⅛-inch bolts, one on each side of the welded part of the extreme end of the thermo-couple. Care is taken to form a tight contact, though not to cause an undue strain on the couple. The dimensions here given for the test specimen are not essential, though convenient; any pieces which will permit of tight contact with the thermo-couple and of readily heating in furnace chamber, may be used.

With the specimen fastened to the couple as just described, the furnace is connected in circuit and the cover placed over the chamber opening. The temperature within the chamber rises steadily. When it becomes 1,700 degrees F. the end of the couple, with specimen attached, is inserted in the chamber. The steel specimen rapidly heats, its temperature being constantly the same as that of the welded junction of the thermo-couple, due to the intimate contact between them. This temperature, indicated by the meter, will rise uniformly until the decalescence point of the steel tested is reached. At

this temperature the indicating needle of the meter becomes stationary, the added heat being consumed by internal changes. These changes completed, the temperature again rises, the length of the elapsed period of time depending upon the speed of heating. With the furnace temperature kept nearly constant at the initial point, here given as 1,700 degrees F., this "speed of heating" will be such as to allow of readily observing the pause in motion of the needle. The temperature at which this occurs should be carefully noted.

To obtain the lower critical point, the temperature of the piece is first raised above the decalescence point by about 105 degrees F. In this condition it is removed from the furnace and rested on top to cool. The decrease of temperature is at once noticeable by the fall of the meter needle. At a temperature somewhat below the decalescence point, varying with the composition of the steel, as previously mentioned, there is again a noticeable lag in the movement of the needle. The temperature at which the movement ceases entirely is the recalescence point. Immediately following there may occur a slight rising movement of the needle, as previously explained.

During these intervals of temperature lag, both during the heating and cooling of the steel, there may occur a small fluctuation in the temperature. In order to get results that are comparable, a definite point in each of these intervals should be considered each time a test is made. Hence, both the decalescence and recalescence temperatures are taken as the points at which the needle first becomes stationary. As all operations of heat treatment of a steel center around its critical point, the importance of knowing these exactly is realized; to make certain, each test should be checked by a second reading. The time required for this is small. A close agreement of two succeeding readings will give assurance of the correctness of the determination.

Results Obtained from Sample Specimens

In order to show graphically the necessity of working carbon steels at the proper temperature points, a series of specimen pieces of the same steel were treated at different temperatures. The steel used contained exactly 1 per cent carbon, that is, it was a "one-point" steel. A number of test specimens were made of this from adjacent parts of the same bar.

First the critical points of this steel were determined. Temperatures were recorded throughout both the heating and cooling. In the diagram, Fig. 2, these values have been plotted. The curve shows grapically the location of the critical points, and also the slight fall or rise of temperature, as the case may be.

With this data obtained, seven specimens of the same steel were heated, in the electric furnace, each to a different temperature. As these pieces were removed from the furnace they were immediately quenched in water. The temperature of the quenching bath was held constant at 45 degrees F. The hardened pieces were then broken at right angles and the fractured surface of each was photographed under a microscope. These photographs are reproduced in Figs. 3 to 9 in the same size as the originals. Due to magnification, the first five of these engravings represent a circular area, the actual diameter of which is but 0.05 inch; while the piece illustrated in Fig. 8 is of 0.1 inch diameter.

An inspection of these shows at once the serious effects on its structure, and hence on its strength, of overheating a piece of steel. The micro-photograph of specimen No. 1, Fig. 3, shows a very badly "burned" steel, as is evidenced by the extreme coarseness of its grain. Specimen No. 2, Fig. 4, hardened at 150 degrees F. lower temperature, shows less coarseness, but is still badly "burned." The succeeding specimens, Figs. 5, 6 and 7, show a gradual improvement, as the temperature at which they were hardened approaches the decalescence point of the steel. Specimen No. 6, Fig. 8, was quenched just after the hardening change in its structure had become complete, at 5 degrees F. above the critical temperature. The very fine grain and closely woven texture of this fracture show a properly hardened steel, one which has both the desired hardness and the maximum tensile strength.

Specimen No. 7, Fig. 9, was hardened just as the temperature reached the decalescence point. This shows clearly the direction in which the hardening moves, namely, from the exterior toward the interior. This would naturally be expected as the temperature of the surface, which is exposed directly to the source of heat, reaches the critical point first. This illustration shows that the structural change has been completed only in the surface layer of the specimen. Here the grain is fine and the steel hardened, while the interior is still in the unhardened state. This condition indicates the necessity of heating the piece uniformly.

While 1,900 degrees F., the temperature at which the Specimen No. 1, Fig. 3, was hardened, represents, of course, a very excessive heat, yet it is not infrequent that carefully machined parts are ruined by overheating even to this degree. The practice of guessing at hardening temperatures can only result in uncertainty.

Conclusions

The hardening of carbon steels for highest quality and greatest saving entails, then, three things. First, a definite knowledge of what constitutes the correct temperature at which to harden the steel. The second point necessitates a positive means of accurately determining this hardening temperature for any carbon steel. The third consideration is that the correct hardening temperature, once determined, is actually carried out in the hardening work. A simple and effective way of doing this is by checking the temperature of the hardening furnace by means of a pyrometer. When there is a large quantity of work to be hardened, economy dictates a permanent installation of pyrometers. The convenience of such installations is manifest. A thermo-couple is placed in each furnace. A number of these, from three to sixteen, depending upon individual conditions, are connected by wire leads, through a selective switch to one meter. By a turn of the switch, the temperature of any furnace may be read at once from the meter. This makes it possible for the foreman to know definitely, at a single point, the temperatures of all of the hardening furnaces in use.

* * *

An aerial exhibition was opened in the Grand Palais, Paris, the last Saturday in September. Some thirty full-sized aeroplanes were exhibited in addition to a dirigible airship and several balloons. There was a striking likeness between all the heavier-than-air machines exhibited. Of course, two types were represented, the mono- and the bi-plane, but the Bleriot machine is the obvious prototype of nearly all the monoplanes, while all the biplanes show important features of either the Wright, Farman or Voisen branches of the biplane family. There were considerably more monoplanes than biplanes displayed, possibly because of the success of Bleriot's cross-channel trip, and, perhaps, also on account of the greater simplicity and cheapness of construction. Improvements are noted in the monoplanes, but no noteworthy improvements are visible over the already tested types of the biplanes.

* * *

The importance that engineering will play in the future in the destruction of harmful insects is, to some extent, indicated by the experiments which have been carried out with great success at Zittau, Germany. According to the *Scientific American*, the beam from a searchlight mounted on the roof of the municipal electric light plant was played upon a forest several miles distant, and the moths to be destroyed came fluttering up the beam in swarms to the light, behind which was the intake of a powerful suction blower. The moths were drawn in by the suction and exhausted into a wire net cage which was removed as often as filled. In one single night 140 pounds of moths representing, by numbers, some 400,000 were destroyed in this way.

* * *

A treaty has been made between the United States and Canada limiting the total amount of water that may be taken for power purposes at Niagara Falls. According to this treaty the power companies on the Canadian side are limited to 36,000 cubic feet per second, and those on the American side to 20,000 cubic feet. The average total discharge of the Niagara river is 250,000 cubic feet per second.

SOME INTERESTING CAM CONSTRUCTIONS*

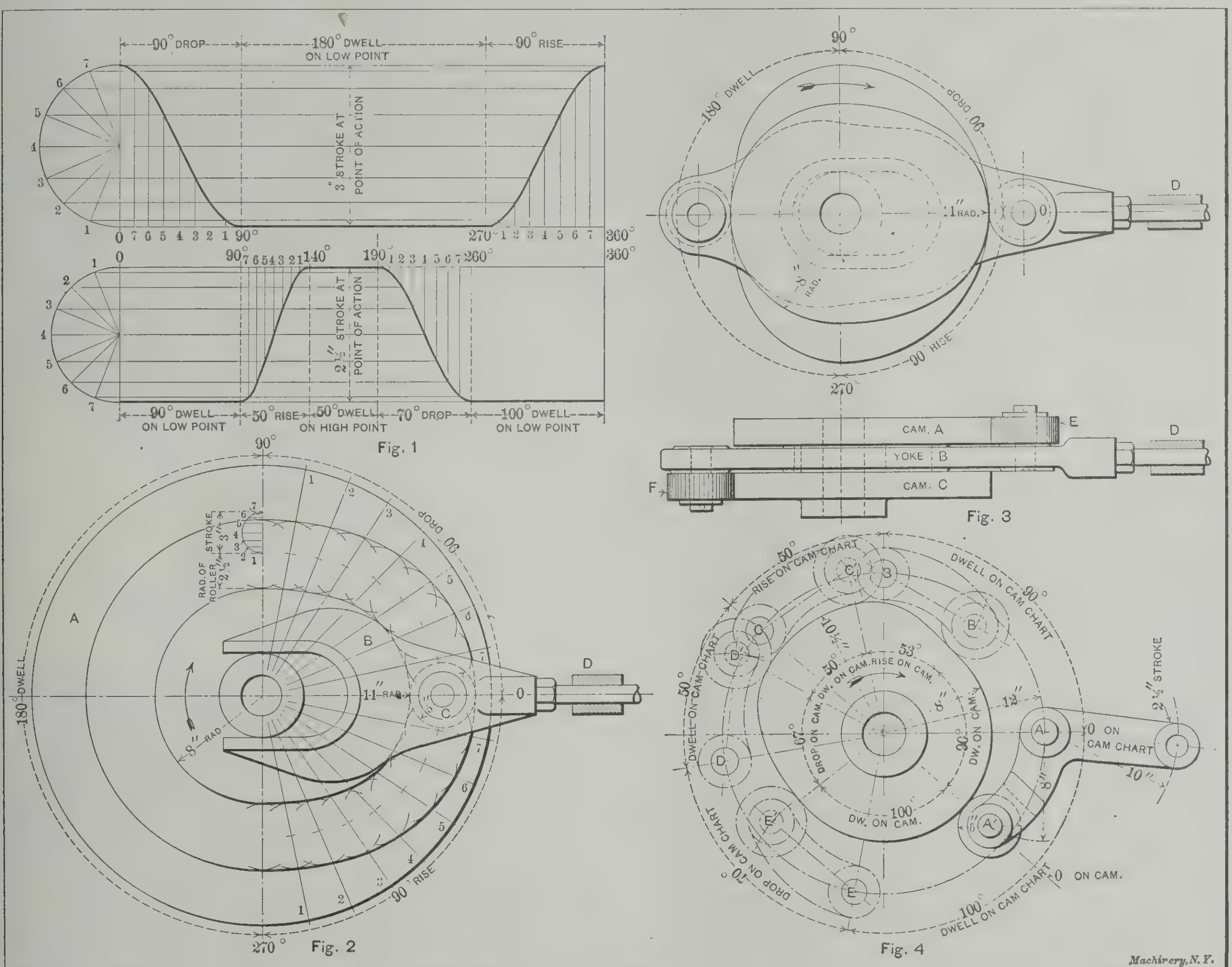
EDWARD PERSON†

When designing automatic machines that are more or less complicated, it is not always possible to avoid the use of cams in order to accomplish the work for which the machine is intended. When several cams are to be used on the same machine, it is necessary to make up a cam chart from which the designer works when laying out the cams. This chart should give the stroke required for the mechanism and indicate what part of the revolution of the cam shaft is required to produce the required stroke, as well as the period of rest. These quantities are given in degrees.

Fig. 1 shows a cam chart for two cams, the curves being crank-motion curves. The first cam, starting at zero, moves the mechanism operated three inches, while turning 90 degrees. There is then a rest or dwell for 180 degrees, and a return movement in the remaining 90 degrees. The mechanism operated by the second cam rests until the cam has turned 90 degrees; the cam then imparts a motion of 2½ inches from 90 to 140 degrees. There is then a dwell for 50 degrees, a return motion during 70 degrees, and finally a 100-degree dwell on the low point of the cam.

The crank-motion curves on the cam chart are constructed as follows: Set off the stroke of the mechanism, three inches in the first case, and two and a-half inches in the second. Construct a half-circle with the length of the stroke as diameter, and divide the half-circle into a certain number of equal parts. Also divide the length representing the drop and rise into the same number of equal parts as that into which the half-circle has been divided. Then draw lines from the dividing points as shown in Fig. 1. The intersecting points will be the points of the curve. It is of importance that these curves be correctly constructed, as this provides for a smooth movement of the mechanism at any point during the revolution of the cam. Of course, these curves do not need to be crank-motion curves, but can be changed to suit conditions.

Figs. 2 and 3 show the constructions of cams laid out from the first cam chart curve in Fig. 1. These cams are working positively in either direction. The construction in Fig. 2 consists of a grooved cam A, and a yoke B forked over the hub of the cam and carrying the roller C, placed in the groove. When revolving the shaft, the yoke, guided by a bushing at D, will move back and forth three inches in a straight line. For laying out the cam proceed as follows: Set off from the zero point on the cam in a direction opposite to that in which the cam revolves, 90 degrees, and from this point set off 180 degrees, and then another 90 degrees, which brings us back to the starting point. Determine the highest and lowest points on the cam, which in this case are located 8 and 11 inches from the center respectively. Set off at the lowest point (as shown at the top of the cam in Fig. 2) the radius of the roller and the stroke of the cam, which latter, of course, is the same as the difference between the highest and lowest points. Draw a half-circle having the stroke for its diameter, as shown, divide the circumference of the half-circle into the given number of equal parts, and draw perpendiculars from the division points to the diameter or base line. Then divide the angles for the rise and the drop into the same number of divisions as that of the half-circle, and draw radii to the division points from the center of the cam. From the points where the perpendiculars intersect the base line draw circular arcs with the center of the cam shaft as a center until the arcs intersect the corresponding angular division lines. Take the points of intersection for centers and draw circles having a diameter equal to the roller diameter. The line tangent to these circles is the true crank-motion curve.



Cam Charts and Different Methods of Laying Out Cams

* For additional information on this and kindred subjects, see "Method of Laying Out and Cutting Cams," MACHINERY, October, 1908, and other articles there referred to. See also MACHINERY'S Reference Series No. 9, "Designing and Cutting Cams."

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The second cam construction, Fig. 3, consists of two cams A and C, one on each side of the yoke B, and two rollers E and F mounted on each side of the yoke. The yoke in this case is also forked over the hub of the cams and guided at D. The cam curve for the top cam is identical with the inner curve in Fig. 2, and is laid out in the same manner, as is also the rise and the drop for the bottom cam. The only difference is that when the top cam has a dwell on the high point the bottom cam has a dwell on the low point, and *vice versa*. This, of course, insures a positive movement both ways.

Fig. 4 shows another cam construction laid out from the second chart in Fig. 1. It consists of only one cam, a lever and a roller. This construction is positive only one way and must be actuated by a spring for returning, but it can be arranged to work positively by making a three-arm lever, a return cam and a return cam roller. The point illustrated in Fig. 4 is the variation of the angles of the cam, as compared with those of the cam charts, due to the rise and the drop of the roller on the end of its lever. Instead of turning the cam shaft in the direction indicated by the arrow, assume that we swing the center of the lever pivot in a circle around the center of the cam, but in the opposite direction to the cam motion. To lay out the cam, we must first assume the length of the lever, the stroke of the cam, and the highest and the lowest points on it. The center of the lever pivot, at the start, will be at zero on the cam chart, and the center of the roller will be at zero on the cam. From the zero of the lever pivot, Fig. 4, set off 90 degrees for the dwell on the low point, 50 degrees for the rise, 50 degrees for the dwell on the high point, 70 degrees for the drop, and then 100 degrees for another dwell on the low point. Draw radii from the center of the cam shaft to each of these divisions. Take the points where these radii intersect the circle along which the center of the lever pivot moves, as centers for circular arcs having the roller arm AA' for radius, as shown at BB', CC', DD' and EE'. Then set off, from the center of the cam shaft, a distance equal to the radius of the cam plus the radius of the cam roller at each of these places (at B' the distance set off would be $8+2\frac{1}{2}$; at C' $10\frac{1}{2}+2\frac{1}{2}$, etc.). The points of intersection between these distances and the arcs struck with radii BB', CC', etc., are used for centers for circles having a diameter equal to that of the cam roller. Now it will be seen by measuring with a protractor, that where the dwell occurs the angle of the cam will be the same as the angle on the cam chart, but where a rise or a drop takes place the angles will be different.* In the present case, the 50-degree rise on the cam chart and of the cam lever will be about 53 degrees on the cam, and the 70 degrees drop on the cam chart will be about 67 degrees on the cam. This is of importance when several movements are used, and one movement starts immediately after another in such a relation that one must come to rest before another starts. The curves for the cam can be laid out in a manner similar to that explained in Fig. 2.

* * *

"A full conception of infinity is impossible to the finite mind," said the learned professor to his class, "and it is doubtful if an approach to it even is possible, but to illustrate in terms that will convey to your minds something of its immensity, let us consider infinite time. Suppose that the highest peak in the Himalayas were a solid diamond mountain and that an eagle came to it to sharpen his beak once in a hundred years. In the lapse of untold billions of centuries that diamond mountain undoubtedly would be worn away to dust. That is an illustration of finite time of great duration, but great as it is we cannot use it as a 'time-stick' to gage eternity."

* * *

In a recent address on Business English at Tufts College, Walter B. Snow, publicity engineer, of Boston, chose the modern advertisement in its display of force, terseness, knowledge of subject and consideration of the person addressed, as typical of the elements to be embodied in commercial intercourse and in technical reports, articles, etc.

* For a more thorough explanation of this kind of cam construction see MACHINERY, October, 1908: Method of Laying Out and Cutting Cams.

THE McKINLEY MANUAL TRAINING SCHOOL, WASHINGTON, D. C.*

GEORGE W. SUNDERLAND†

The subject of industrial education is becoming more and more important throughout the United States. It is now recognized that the training of the hand and mind together confers far greater benefits than the training of either separately. The object of industrial education is not necessarily that a boy or girl who has passed through the manual training school must follow any of the trades or vocations of which

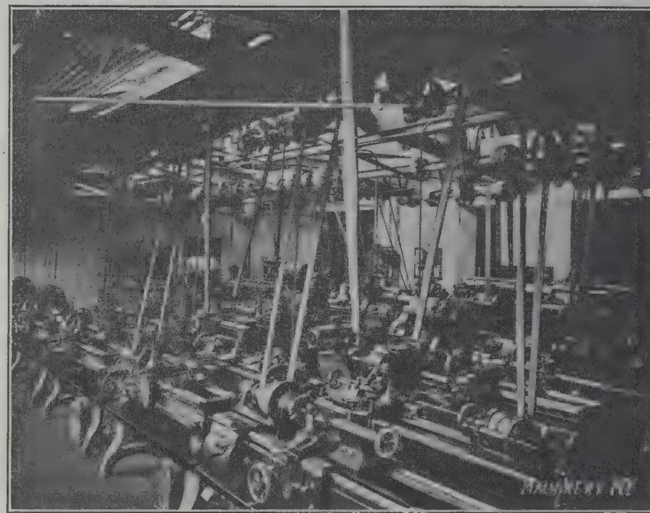

Fig. 1. View of Machine Shop, McKinley Manual Training School, Washington, D. C.

they have acquired some knowledge; but education of this kind gives them a broader view of the advantages of a trained hand in combination with a trained mind, and it aids them in determining for themselves what they are best adapted for. Nearly all of the largest cities in the United States now have manual training or technical high schools, where regularly prescribed courses are followed, while in small communities the idea is carried out to some extent, even if sometimes on a reduced scale.

Among the foremost manual training schools in the country is the McKinley Manual Training School of Washington, D. C. The school-building is strictly fireproof and contains seventeen class-rooms, besides three rooms devoted to chemistry, five

Fig. 2. Another Interior of the Machine Shop

rooms to physics, four rooms to free-hand drawing, two rooms to domestic art, four rooms to domestic science, four rooms to mechanical drawing, one library, one assembly hall with a seating capacity of 700, one art metal shop, one machine shop, one forge shop, two carpenter shops, one engineering laboratory, one shower bath-room, and the necessary lavatories, etc. The very names by which these rooms are designated suggest the purposes for which they are used, but a long and detailed

* For additional articles on this and kindred subjects previously published in MACHINERY, see issue of September, 1907, Education for Industrial Workers, and the articles there referred to.

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description would be required to convey an adequate idea of their complete and substantial equipment.

Three courses of study are provided. A general scientific course, a technical preparatory course (both requiring four years), and a special technical course, requiring two years. In connection with the manual training work, there is given a thorough course in English, French, German, physics, chemistry and mathematics. The part of the course which is of especial interest to the readers of MACHINERY, is the machine shop course. This includes instruction in the use of measuring instruments and tools, and as thorough a course as possible in bench, vise and floor work, drill press, lathe, planer, shaper, milling machine and grinding machine work, as well as instruction in the first principles of gearing.

The school has its own plant for power, heat, light and ventilation. The equipment consists of four Heine safety boilers of 75 horse-power each; one Ames high-speed, direct con-

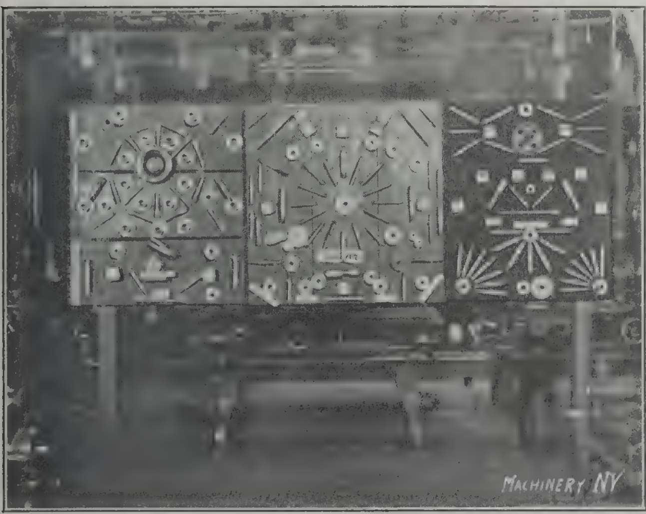


Fig. 3. An Exhibit of Work made by the Students in the McKinley Manual Training School

nected engine of 150 horse-power with a Westinghouse direct-current 100 K. W. generator, 125 volts, 800 amperes, 200 R. P. M.; one American Ball engine and generator, 50 horse-power, 125 volts, 230 amperes, 323 R. P. M.; one General Electric engine and generator, 80 horse-power, 125 volts, 400 amperes, 400 R. P. M.; one Johnson temperature regulator; one Cochrane feed water heater and return tank; two steam pumps for the boilers; two Sturtevant fans connected direct to motors, each 16 horse-power, 110 volts, 114 amperes, 975 R. P. M.; one Westinghouse 15 horse-power steam turbine driving a centrifugal pump.

The equipment of the machine, forge and carpenter shops will no doubt be of interest and value to others interested in the equipment of manual training schools. The following is a list of the machinery in the machine shop:

One 16-inch—10-foot Pratt & Whitney new model engine lathe, motor-driven.

Two 14-inch—6-foot Pratt & Whitney tool-room engine lathes, motor-driven.

One 16-inch—6-foot Hendey geared head engine lathe, motor-driven.

Two 14-inch—6-foot F. E. Reed geared head engine lathes, motor-driven.

Four 14-inch—6-foot F. E. Reed engine lathes, belt-driven.

Six 12-inch—5-foot F. E. Reed engine lathes, belt-driven.

One 14-inch—6-foot Hendey engine lathe, belt-driven.

Four 12-inch—5-foot Hendey engine lathes, belt-driven.

One No. 1 Brown & Sharpe universal milling machine, belt-driven.

One No. 3 Brown & Sharpe universal milling machine, belt-driven, with all attachments.

Three 16-inch Stockbridge shapers, latest type, motor-driven.

Three No. 1½ Brown & Sharpe universal milling machines, motor-driven, with all attachments.

One 16-inch Potter & Johnston shaper, belt-driven.

One 36-inch—6-foot Pease planer, belt-driven.

One 24-inch Prentice drill press, belt-driven.

One 22½-inch Willey drill press, motor-driven.

One 12-inch Willey sensitive drill press, motor-driven.

One Wilmarth & Morman "Yankee" drill grinder, motor-driven.

One No. 3 Brown & Sharpe cutter and reamer grinder, motor-driven.

One No. 2A Landis universal grinding machine, motor-driven.

Two Willey tool grinding machines, motor-driven.

One Walker "Globe" grinding machine, belt-driven.

One Hisey center grinder, motor-driven.

One Willey center grinder, motor-driven.

One Pratt & Whitney centering machine, motor-driven.

One Higley metal saw, motor-driven.

One Chicago gas furnace.

One Greenerd arbor press.

One L. S. Starrett display cabinet.

One Brown & Sharpe display cabinet.

One "Pike" oilstone display cabinet.

The shop is equipped with the necessary benches and vises. The tool-room is stocked with a full line, from a hack-saw to a micrometer, including the Pratt & Whitney Co.'s small tools. The check system is used. The stock-room is furnished with "New Britain" metal racks and metal shelving. It makes the most complete and non-combustible arrangement that can be found. The Higley metal saw is placed in the stock-room to give greater convenience in handling material.

The carpenter shop has a stock- and tool-room and a full line of tools as follows:

Thirty-six Oliver lathes, motor-driven.

One Oliver band-saw, motor-driven.

One Oliver buzz-saw, motor-driven.

One No. 3 Oliver trimmer.

One Oliver jig-saw.

One Oliver band-saw, belt-driven.

Twenty F. E. Reed lathes, belt-driven.

One Brown & Sharpe grindstone, motor-driven.

Two Willey tool grinders, motor-driven.

One demonstration bench for molding.

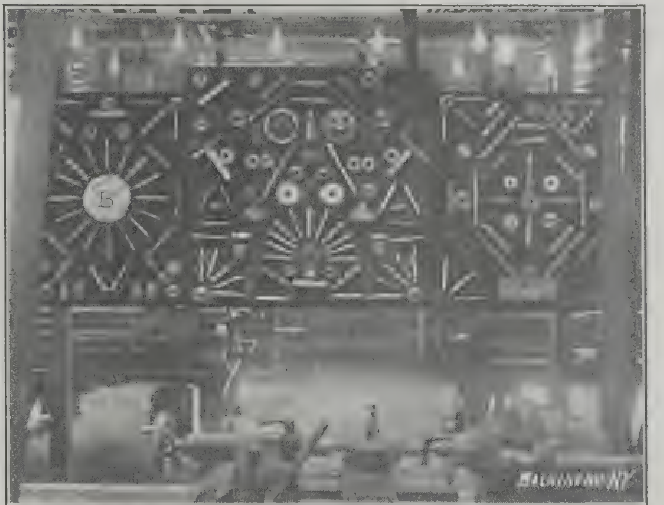


Fig. 4. Another Exhibit of Students' Work

A course in bench work is provided in connection with wood turning and pattern-making.

The forge-shop has the following equipment:

Twenty No. 02 Buffalo down-draft forges.

Ten B. F. Sturtevant ideal down-draft forges.

One No. E1 Dupont power hammer.

Thirty-one anvils.

One Buffalo 7½ horse-power blower, motor-driven.

One Sturtevant, 15 horse-power exhaust fan, motor-driven.

One Norton floor grinder 18-inch, belt-driven.

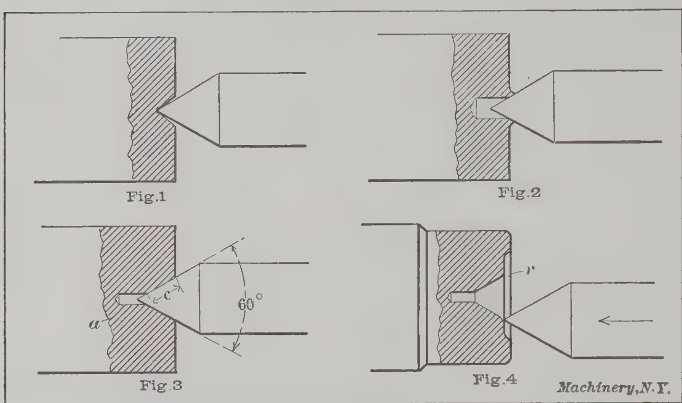
One "McKinley" drill press, belt-driven.

Two of the accompanying half-tones, Figs. 1 and 2, show interior views of the machine shop, and Figs. 3 and 4 illustrate some of the work done by the students. A great deal of the success of the school is due to the untiring efforts of Mr. J. A. Chamberlain, supervisor of manual training of the District of Columbia, who has been with the school since its infancy, and also to Dr. George E. Myers, the principal, who has shown great interest in all matters pertaining to shop work.

MACHINE SHOP PRACTICE*

CENTERING

While the importance of centering work properly, is appreciated by almost every machinist and most apprentices, still, in spite of this fact, inaccuracy in a turned part is often the result of haphazard centering. This is perhaps due more to the lack of care and thought than to anything else. When there are no special tools provided for centering, of course, too much cannot be expected in the way of accuracy; but even though the equipment consists only of a center-punch, there is no excuse for the form of center illustrated in Fig. 1. The center-punch should, however, never be used if it can be avoided. A better method is to locate and mark with a punch, centers in each end of the work and then drill and ream the ends with a combination drill and countersink, such as is illustrated on the Shop Operation Sheet accompanying this number. The center will then appear as shown in the sectional view, Fig. 3. The small straight hole *a* prevents the point of the lathe center from coming in contact with the work and insures that there will be a good bearing throughout the conical surface *c*, providing the angularity of both the lathe and work centers is the same and their axes coincide.



Figs. 1 to 4. Centers of Incorrect and Correct Form

Many shops are equipped with a regular centering machine. If such a tool is available, it is not necessary to locate centers in the ends of the work, as the chuck of the machine is so constructed that it automatically centers shafts of any diameter within its capacity, with reference to the drill. The center shown in Fig. 2, which is formed by simply drilling a straight hole in the end of the work, is, obviously, bad practice in more than one respect. Fig. 4 shows a form of center which is often found in the ends of lathe arbors. As the illustration shows, the mouth of the center is rounded at *r* and the end of the arbor is recessed. This is done to protect the center against bruises. The rounded corner is particularly desirable as the point of the lathe center is thereby prevented from catching on it when, at times, it is moved rapidly towards the work, which is not being held centrally by the workman.

When stock which is to be turned, is bent, it should be straightened before the centers are drilled and reamed. If

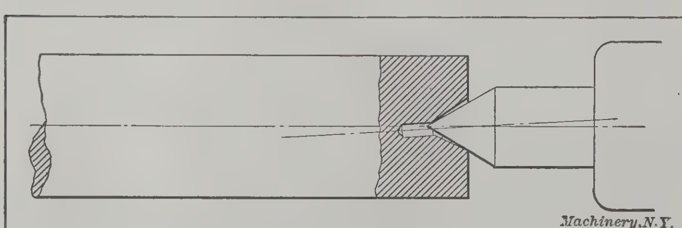


Fig. 5. The Poor Center Bearing shown is the Result of Centering before Straightening

the work is first centered and it is then bent considerably to make it straight, the bearing on the lathe center would be as shown in Fig. 5; consequently, the center would wear unevenly with the result that the surfaces last finished would not be concentric with those which were turned first.

Stock for tools such as reamers, mills, arbors, etc., which need to be hardened, should always be centered so that the rough stock runs approximately true. This is not merely to insure that the piece will be true when it is of the required size, as there is a more important consideration, the disregard of which often greatly affects the quality of the finished tool. As is well known, the degree of hardness of a piece of steel that has been heated sufficiently and then suddenly cooled, depends upon the amount of carbon that it contains, steel

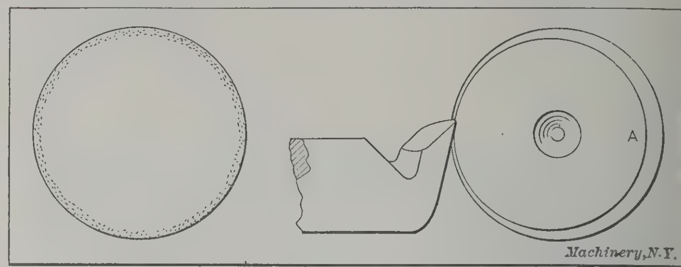


Fig. 6. Tool Steel should be centered Concentric, in order to remove the Decarbonized Outer Surface

that is high in carbon becoming much harder and more brittle than that which contains less carbon. Now the amount of carbon found at the surface, and to some little depth below the surface of a bar of steel, is much less than the carbon content of the rest of the bar, as illustrated diagrammatically in Fig. 6 by the shaded area of the view to the left. (This decarbonization is probably due to the action of the oxygen of the air on the bar during the process of manufacture.) Consequently, stock which is to be used for hardened tools should be enough larger than the finished diameter and so centered that this decarbonized surface will be entirely removed in turning. For example, if when making a reamer, the stock is so centered that the tool removes the decarbonized surface only on one side, as shown to the right in Fig. 6, obviously, when the reamer is finished and hardened, the teeth on the side *A* will be much harder than those on the opposite side. It will thus be seen that stock for such tools should not be too near to the finished size, in order that the decarbonized part will be entirely turned away. The depth to which the carbon is burned out increases with the size of the stock, and also varies somewhat with different pieces of steel. Generally speaking, about 1/16 or 3/32 inch should be removed for diameters near 1 inch, while for sizes of 2 and 3 inches, as much as 1/8 to 3/16 inch in one case and 1/4 inch in the other should be removed, respectively.

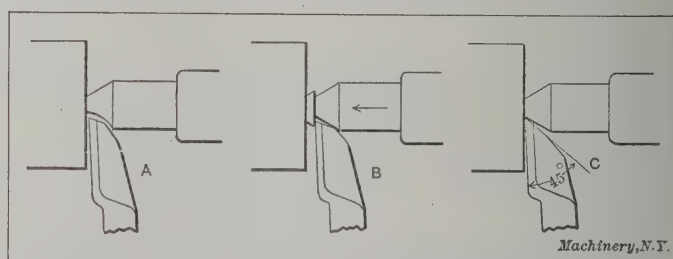


Fig. 7. Three Methods of Facing the End Square

As a piece of work would hardly be properly centered until the ends are faced square, we shall consider this operation, which, though simple, seems to be the cause for considerable comment. Some advocate the use of centers that are cut away, as shown at *A*, Fig. 7, so that the point of the tool may be fed in far enough to face the end up to the center. Others instead of using a special center simply loosen the regular one slightly, and then with the tool in the position shown at *B*, face the projecting teat by moving both tool and center simultaneously as shown by the arrow. This last method hardly represents good practice, but whenever it is employed, care should be taken to remove any chips from the center hole which may have entered. A method which is better than loosening the regular center or employing a special one, is to provide clearance for the tool point by grinding it to an angle of approximately 45 degrees, as shown at *C*. Providing the tool is not set too high, it may then be fed right up to the lathe center and the end squared without difficulty. As for the special center, the use of special tools and appliances in a shop should always be avoided unless they are essential to economical production, or their use makes it possible to accomplish the same end with an expenditure of less energy.

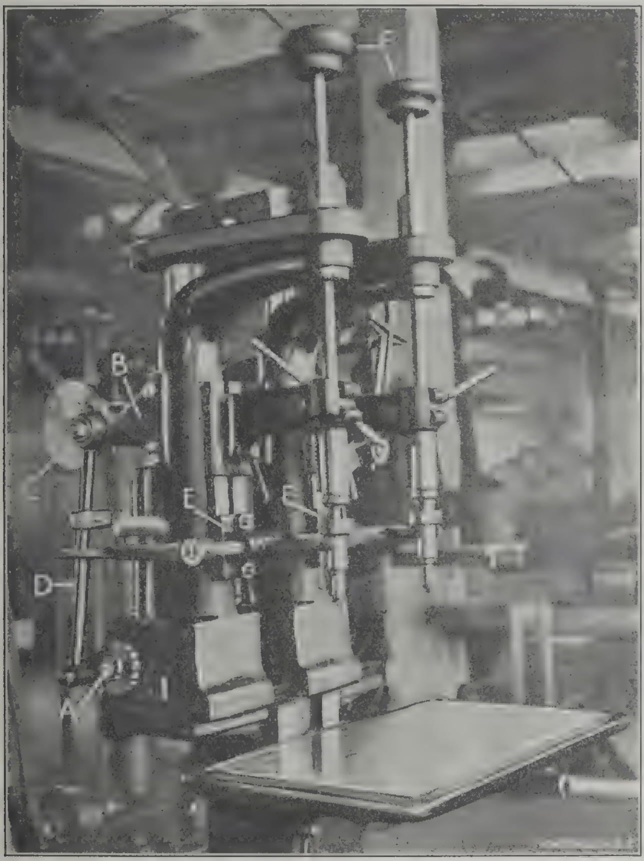
* With Shop Operation Sheet Supplement.

DRILL PRESS VALVE GRINDING ATTACHMENT

A. G. KENYON*

The attachment described in the following was made for the purpose of grinding in the valves of automobile cylinders in a drill press instead of by hand, as has been the practice for some time past. This operation has always been a source of some little annoyance and a time consumer, ever since manufacturers began to build engines in large quantities. A minute saved here and there very often means many more engines built in a month and many dollars saved on the month's expenses. The device shown in the accompanying engraving has proved itself well worth the amount it cost, although it was not at all expensive.

This attachment was designed for and placed on a two-spindle drill press made by the Fenn Machine Co. of Hartford, Conn. The machine is of the type in which the spindles are adjustable for center distance and it has a cross driving shaft *A* through the bases of the upright arms. This shaft is ordinarily driven by a pinion on the driving pulley which,



Drill Press equipped with a Special Attachment for Grinding Valves

together with the loose pulley, is carried on a stud set into the main stand casting. The cross shaft drives vertical shafts which are connected to the spindles of the machine by chains and sprockets. In order to make the attachment, the stud carrying the loose and driving pulleys was removed and also the gear on the end of the cross shaft. Castings *B* were made to fit the upright arms of the press and were cored out to allow for babbitting with the countershaft in place. The same two pulleys that were on the machine originally were placed on this shaft at one end. On the other end there is a disk, *C*, about six inches in diameter, which has a hub on one side to allow for set-screwing to the shaft. In this disk at the proper radius there is a shoulder-stud or crank-pin as shown. On the lower cross shaft *A* two ratchets are mounted, one made right- and the other left-hand. These ratchets are pinned to the shaft and in between them is placed a link or lever which carries two pawls to engage with the ratchet teeth. This lever also has a pin at its outer end and is connected to the upper shaft crank-pin by a connecting-rod *D*. The stroke of this connecting-rod is of the proper length to give the cross-shaft enough turn to move the spindles just half way around and then back again, the same as a workman does when he grinds valves by hand. One ratchet has twice as many teeth on its circumference as the other, and this one is placed on the inside. The pawl that drives this inside ratchet has a hardened pin on its side that trips over a block cut to the proper shape to cause it to disengage at nearly the bottom of the stroke. In this way the spindles of the machine make a full half revolution in one direction and then reverse and make almost a half revolution in the other. The result is that the valve, in the course of grinding, is advanced around its seat every other move, so that the seating is absolutely perfect. The reason for having one ratchet with twice as many teeth as the other, is to provide for the movement due to the momentum of the driven parts at the end of a stroke, so that the pawl will engage at almost any point on the circumference. In this way lost motion is largely eliminated, and consequently, there is no knocking or vibration while the machine is running.

As it is common practice with mechanics to place a spring under the valve head, while grinding, to raise it occasionally in order to let the grinding-in compound settle and change in the seat, this is done in this case. Two castings *E* were made to fit the front T-slot, and these support a rod three-quarters of an inch in diameter on which is placed three forgings, two of which are forked at the end and straddle the spindles of the machine as shown. The other is forked at the end and straddles the connecting-rod. Collars were made to fit the spindles and a clip was also made to fit the connecting-rod. This clip is so adjusted that when the connecting-rod is at the bottom of the stroke, it strikes the forked lever and causes it to move down. This brings the forked levers at the spindles in contact with the collars on the spindles and, consequently, raises them slightly. As the pressure is then removed from the valve, it rises just the same as it would if it were being ground by hand. These levers are so located with reference to the collars on the spindles, that none of the grinding pressure is removed from the valves except at the time of lifting. The grinding pressure is obtained from two cast-iron weights *F* on the spindle shafts. The drivers are like a screw-driver, except that in the center of the blade a center is left projecting so that it will settle in the countersunk lathe center usually left in the heads of valves. These drivers are placed in old drill shanks that fit the sockets of the spindles. These drill shanks are bored out a little larger than the shank diameter on the driver and a pin is placed through them that fits loosely in the driver shank. This gives the driver a sort of floating action and allows the valve to find its own seat and center, which it would not do if the valve center was not quite in line with the spindle center and a rigid driver were used.

The cylinders, the valves of which are ground with this fixture, have four cylinders cast "*en bloc*" with the valves all on one side. As the distance between the spindle centers is adjustable, they are set to the first and fifth valves so that it only takes four moves to complete the grinding of one set of valves. Either spindle can be raised independently of the other at the will of the operator by the ordinary means for raising a drill press spindle, which was not interfered with in the least in attaching the device. Either spindle can be stopped also by simply shifting a lever on the back of the machine to a neutral point. This is also a part of the regular equipment of the press that was not interfered with.

This device has been in use now for some time and has repeatedly ground all eight valves in a cylinder, perfectly, in seven minutes. It positively does not ring the valve, nor does it chatter the seat in the least, and in every way it has proved successful beyond our expectations. The engraving shows how comparatively simple the device is to make and attach, if a shop has a drill press of this make or style. This fixture has solved the valve grinding troubles in our own shop for some time and we hope that if anyone else builds one, it will be as successful as ours has been.

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* * *

The Prussian state railways have specified that 214, or about 35 per cent, out of 611 locomotives ordered to be delivered between October, 1909, and March, 1910, are to be provided with Schmidt superheaters.

SOME ECONOMIES IN MAKING DRAWINGS

W. E. WILKINSON*

The engineering staff connected with a manufacturing establishment is usually regarded as a necessary evil because it is not directly remunerative, and it is tolerated only because it cannot well be dispensed with; this is because drawings and designs are not an end in themselves, but a means to an end—a graphical representation of ideas, more or less thoroughly depicted, for the conveyance of the same to others to be wrought out; concrete thoughts in a universal language, if one chooses to put it that way. Whatever ways and means of shortening processes and eliminating unnecessary expense, that can be employed without depreciating either the quality or quantity of work produced is of interest to all concerned

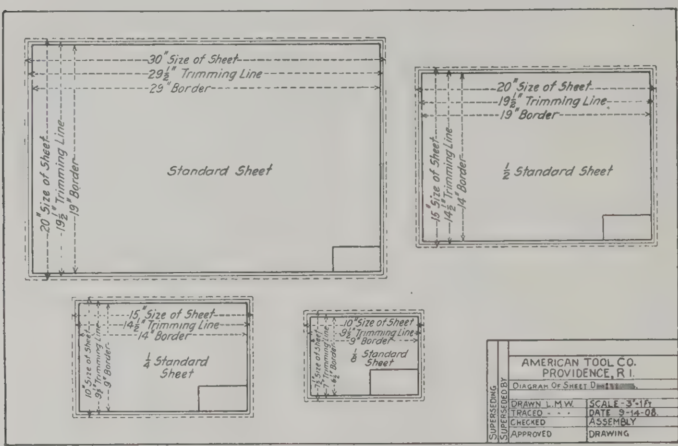

Fig. 1. Dimensions of Standard Drawings

with such offices. With these objects in view the following suggestions are made, which are thought to be generally applicable in any engineering office or drawing room, whatever the size may be.

The best general practice seems to be to have competent designers for making general plans who will pencil the work only; detail draftsmen and tracers to complete the work; efficient checking and inspection of each part; all drawings to be made to scale and on standard-sized sheets invariably; each detail made separately with as many views on the sheet as may be needed to make the subject clear. The advantages of small size sheets are that they are more convenient in the shops and if subsequently changed—as most are—the changes do not affect other detail sheets. The smaller sheets should be subdivisions of the larger, as shown in Fig. 1, so that if desired the entire construction, including the details, may be blueprinted on large sheets and the whole suitably bound into uniform-sized folios or booklets.

The first suggestion is that each sheet of tracing cloth be given to the tracer with the border and title stamp printed on it. The advantages are that the sheet will be smooth and flat at the start, absolutely uniform in size, appearance, title and all that pertains to it, and only the blanks in the title will need to be filled in by the detailer. The prime advantage is the saving in time, which will range from 10 to 25 per cent in average cases, and even more on small sheets, where the work detailed is comparatively quickly executed. Hand-written titles are an abomination unless done by an expert, whose time should be better employed. Rubber stamp work is seldom satisfactory and no good substitute for a properly printed title is thought to exist. The first expense may seem heavy, as it means the purchase of a considerable amount of cloth at one time, but there is no waste or time lost in cutting, which will more than counterbalance the slightly increased cost of having the material cut and printed in quantities.

A second economy lies in the use of properly prepared lists of every possible small part, such as screws, bolts, nuts, washers, pins, etc., using a symbol for the same in place of making detail drawings. In fact, this list system is capable of almost indefinite expansion, limited only by the special requirements of the particular factory in which the work is to be done; besides serving as economizers of time, they materially prevent errors and mistakes and also serve to avoid the drawing of a multiplicity of small parts, which are almost duplicates. Such lists may have at their head a drawing representing the object and a symbol, as a letter, used exclusively for it. In place of dimensions on the object, let the same be given symbolically and the list so arranged that all of its proportions beginning with the smaller sizes, preferably, can be determined and a distinguishing mark, as a numeral, be united to the subject symbol so that its relative size may be known at a glance.

Another suggestion, perhaps more applicable to larger objects having a greater number of dimensions, is to have printed sheets bearing a representation of the object, the dimensions being left blank to be filled in by the draftsman as may be required. In place of printed objects, which would be expensive if but few of a kind were required, the same results may be attained by well executed tracings, filling in the blank dimensions on the prints, the same as would be done on original drawings (see Fig. 2). Don't forget to file a duplicate, however, for future reference.

Where mere sketches are required, cross-section paper, a sheet of carbon and a hard copying pencil may be utilized, but this will not do very well for permanent records and is a make-shift at best.

A further economy in any engineering department may be effected by the use of a record file, kept carefully and fully up to date. The time lost in hunting for some mislaid drawing is not productive of profit or pleasure to any concerned, yet it is the too common experience. Possibly if less cheap (?) labor were employed and this work more generally in the hands of competent persons, made responsible for the instant production of any drawing, the results would justify the expense.

Of course a blueprint machine is installed if the office is of any considerable size, but how about the facilities for washing and drying prints? A sloppy sink may answer for the first, but on a dull or rainy day, wet paper dries slowly and a delayed print often means direct loss by reason of holding up the mail, a customer or a machine. A steam coil or electric heater can generally be readily arranged and will save its cost many times over in a short time.

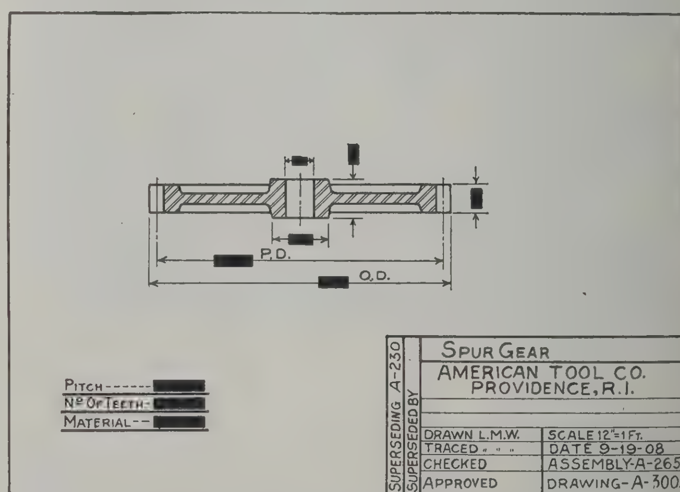

Fig. 2. Printed Sheet with Representation of Commonly used Part and Blank Spaces to be filled in by the Draftsman

A mistake frequently made is to change tracings, involving erasures and re-inking; generally the tracing is spoiled and in any case is lost as a record. It is far better to retrace wholly, making such changes as are desired, as less time is likely to be required and better results attained, while both the old and new tracings may be preserved.

The use of tracing paper is also thought to be a mistake, as it is so easily crumpled, torn and rendered useless for permanent records; the practice can only be condoned on the possible score of extreme urgency.

In conclusion, as time is the most important factor in drawing-room expenses, it should be the duty of some one constantly within reach to see to it that supplies are immediately available to such as require them, and that sufficient data be given so that workmen do not have the common excuse of waiting for this or that, when idle, be it an article of use or a word of explanation or information.

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FORMERS FOR CUTTING BEVEL GEARS*

The most common method of making bevel gears at the present time is, perhaps, that of using formers for shaping the gear tooth. The pin or roller, controlling the part in which the cutting tool is held, guides this so that a tooth of the same shape as that of the former will be cut by the tool. It would seem at first that a great many different formers would be required in order to make possible the cutting of bevel gears of different pitch diameters, pitch and pitch cone angles. It is the object of the following analysis to show that correct bevel gear teeth may be planed by the use of a comparatively small number of formers.

In Fig. 1 a bevel gear is shown, and at the left is indicated the former, the path of the cutting tool being guided by a pin moving over same. The gear here shown has a comparatively wide face. Imagine this gear cut up into a number of gears with narrow tooth face. These gears would then have the same number of teeth, but they would have different pitch diameters, and consequently would be of different pitch; yet all being a part of and identical with a single gear which can be cut by a single former, it is clear that a single former is sufficient for cutting all bevel gears within the capacity of the machine without regard to the pitch, provided the gears have the same number of teeth and the same pitch cone angle.

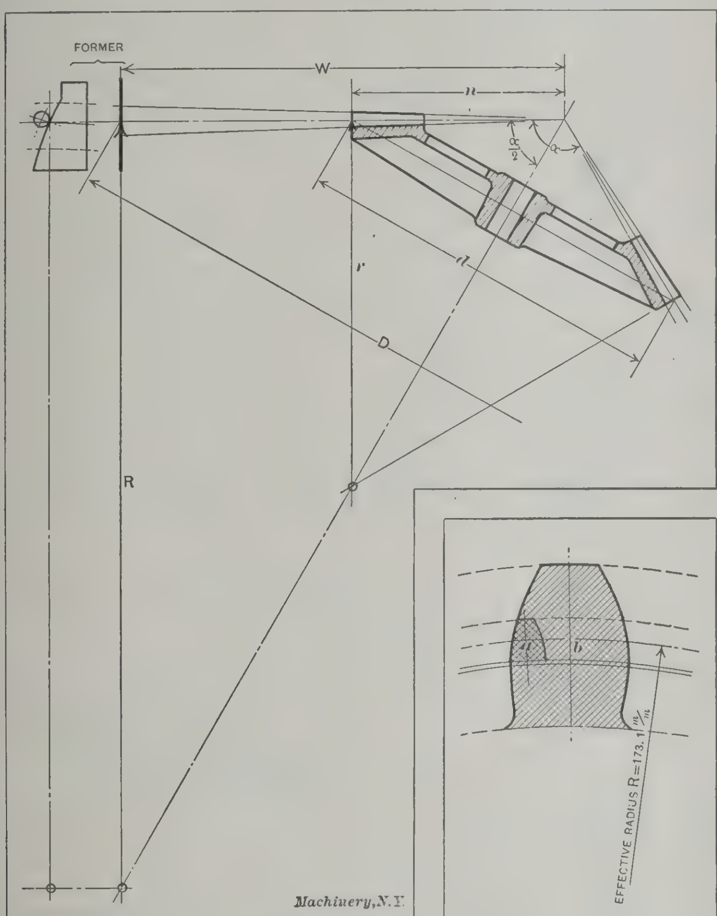


Fig. 1. Diagram for Proving that the Shape of the Former is Independent of the Pitch of the Bevel Gear

Fig. 2. Diagram showing that the Same Former can be used for Planing Different Numbers of Teeth

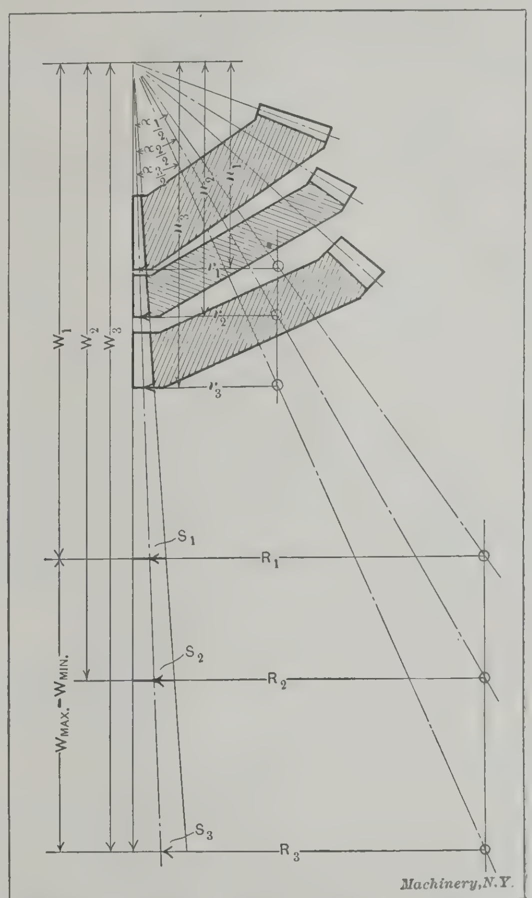


Fig. 3. Diagram showing how Correct Bevel Gear Teeth can be cut with a Limited Number of Adjustable Formers

On account of its simplicity, the involute form of tooth is almost exclusively used for bevel gears, and the following investigation will cover this form of tooth only. The form of the involute curve depends entirely on the length of the radius r (Fig. 1). This radius equals $\frac{d}{2}$ divided by cosine $\frac{\alpha}{2}$. In the following this radius r will be known as the *effective* radius.

In Fig. 2 are shown two teeth from gears having widely different pitch. The illustration indicates how the same former can be used for both teeth provided the former is large enough so that the full length of the tooth flank of the larger tooth can be formed from it. It is clear that if the bevel gear planing machine is so constructed that the former can be adjusted for planing the opposite side of the tooth, then the same former will be suitable for cutting all gears having the same effective radius, irrespective of the number of teeth in the gear; therefore the conclusion previously arrived at may be further extended by saying that within the capacity of the machine, all bevel gears having an equal pitch cone angle can be cut with the same former irrespective of the pitch or the number of teeth. In other words, the shape of the former depends on the angle of the pitch cone only.

The question of the angular limits of the pitch cone angle between which each former can be employed without serious inaccuracy in the tooth form is a highly important one. In other words, it is necessary to determine how many formers will be required for the full capacity of the machine, assuming, for instance, that it will commence to cut gears with a pitch cone angle of about 10 degrees up to 160 degrees. Certain (German) makers of milling cutters for spur gear teeth make these in sets of 15, this giving a very close degree of accuracy for all numbers of teeth. It would be reasonable to base calculations for limits of tolerance for bevel gear formers on the same basis as has been used for determining the number of teeth for the 15 cutters in a set of spur gear cutters. An example may illustrate this more clearly. Assume that the bevel gear planing machine has a capacity for cutting all bevel gears up to a modulus of 20 and with pitch cone angles of from 10 to 160 degrees. Assume that the smallest number of teeth is 12. Then we have the required circular pitch for the former (see Fig. 1):

$$\text{Circular pitch} = \frac{W \sin \frac{\alpha}{2} \times 2\pi}{\text{Number of teeth}}$$

and the modulus is

$$\text{Modulus} = \frac{\text{Circular pitch}}{\pi} = \frac{2W \sin \frac{\alpha}{2}}{\text{Number of teeth}}$$

In this case then the modulus equals 64.5, W being equal to 1,500 millimeters and a being assumed as 30 degrees, this

* Abstract of an article by H. Becker, *Werkstatts Technik*, September, 1909. See also an article entitled Adjustable Former for Bevel Gear Planing, MACHINERY, December, 1906.

being the greatest angle that ought to be used when the number of teeth equals 12. The modulus found is the greatest one for any former for the machine, and from this one the other formers must be determined.

We have previously said that the involute form depends only on the pitch cone angle, or on the length of the effective radius r. The number of teeth in the present case corresponding to the largest pitch cone angle $\alpha = 160$ degrees would be

$$\text{Number of teeth} = \frac{2W \sin \frac{\alpha}{2}}{\text{Modulus}} = \frac{2 \times 1{,}500 \times \sin 80^\circ}{20} = 148.$$

TABLE GIVING PITCH CONE ANGLES FOR DIFFERENT FORMERS

No. of Spur Gear Cutter (or Corresponding Bevel Gear Former)	No. of Teeth for which Spur Gear Cutter is intended	Pitch Cone Angles for which Former can be Used	Exact Angle to which Former Corresponds
1	12	98° 48′— 10° 35′	10°
1½	13	10° 36′— 11° 25′	10° 55′
2	14	11° 26′— 12° 13′	11° 55′
2½	15— 16	12° 14′— 14° 1′	13°
3	17— 18	14° 2′— 15° 27′	14° 30′
3½	19— 20	15° 28′— 17° 3′	16°
4	21— 22	17° 4′— 18° 37′	17° 30′
4½	23— 25	18° 38′— 21° 1′	19° 30′
5	26— 29	21° 2′— 24° 9′	22° 20′
5½	30— 34	24° 10′— 28° 3′	26°
6	35— 41	28° 4′— 33° 23′	30° 30′
6½	42— 54	33° 24′— 42° 53′	37°
7	55— 79	42° 54′— 59° 27′	49°
7½	80—134	59° 28′— 87° 53′	70° 30′
8	135— 00	87° 54′—180°	122°

From this equation, solved for $\frac{\alpha}{2}$ we can easily determine the angles which correspond to the numbers of teeth for which the spur gear cutters are made; and in this manner, by comparing with a list of cutters for spur gears and seeing the number of teeth for which each cutter is intended, we can determine the limits of the pitch cone angles for which each former should be used. The accompanying table shows the results obtained from these calculations, and also gives the angle for which each former should be made.

While a machine provided with formers made with the limits indicated will cut gears which are practically correct, it would be advisable to have special formers made for such ratios as 1 to 1, 1 to 2, 2 to 2, 2 to 3, etc., so that in these cases absolutely correct teeth can be cut.

One of the most interesting considerations in connection with this subject is yet to be mentioned. While the formers are made for a certain pitch cone angle, and it therefore would appear that it would not be possible to make a bevel gear with perfectly correct teeth, except if it had a pitch cone angle corresponding to the angle for which the former had, in particular, been made, it is possible by a method now to be described, to produce theoretically correct teeth for all pitch cone angles with the formers mentioned. In Fig. 3 are shown three bevel gears with different pitch cone angles; the effective radii r_1, r_2, r_3, however, are equal for the three bevel gears. Therefore,

$$n_1 \tan \frac{\alpha_1}{2} = n_2 \tan \frac{\alpha_2}{2} = n_3 \tan \frac{\alpha_3}{2}$$

From what has previously been said, it is clear that for producing the teeth in these gears one can use the same former, provided the distances W from the former to the apices of the pitch cones be made to correspond. If, for instance, on a certain machine W equals 1,000 millimeters, and an adjustment of 300 millimeters is possible, then $W_{max.}$ equals 1,300 millimeters. If the former corresponds to a pitch cone angle of 90 degrees when W equals 1,000 millimeters, then it will correspond to a pitch cone angle of 75 degrees 20 minutes when W equals 1,300 millimeters. It is also clear that when passing from 1,000 to 1,300 millimeters the former comes into intermediate positions corresponding to all angles between 90 degrees and 75 degrees 20 minutes. This arrangement has the advantage that a very few formers make it possible to cut theoretically correct teeth for every angle within the limits of 10 to 160 degrees, even when the limits of the adjustment of the former on the machine are small. If the limit of adjustment of the former on the machine increases, it is evident that the required number of formers will decrease correspondingly, and a very few formers will be required for cutting correctly all bevel gears, whatever the pitch, pitch cone angle, or number of teeth.

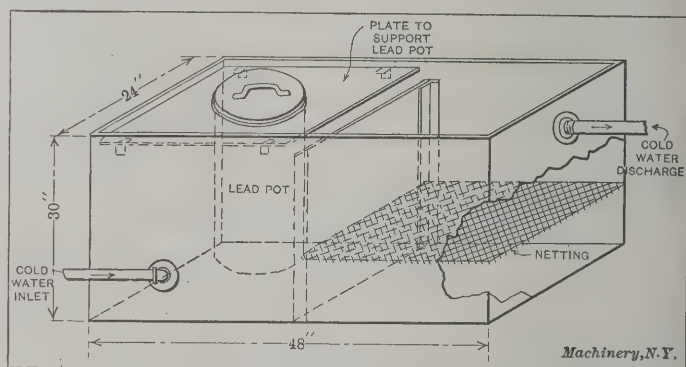
* * *

PROCESS FOR HARDENING CAST IRON

R. F. WILLIAMS*

An improved process whereby cast iron in the rough or in the finished state may be hardened or tempered, the hardness extending completely through articles of comparatively large dimensions, is described in the following. One of the principal objects of this process is to provide a cheap and simple method of rendering iron castings so hard that they may be used for many purposes in the place of steel, thus reducing the manufacturing cost of a large number of articles. The various steps of the process and the manner of carrying it out are here described. The castings which are to be treated by this process may be completely finished as regards machine work before they are hardened, and it will thus be seen that the wear on the machine is greatly reduced and the necessary labor is also less than where similar articles are made from hardened steel.

The casting is first heated in any suitable or convenient heating device, until it reaches a temperature sufficient to cause the casting to glow, or, in other words, to what is known as a cherry red heat. It is then dipped in a bath which consists of practically anhydrous acid, of high heat-conducting power, preferably sulphuric acid of a specific gravity of from 1.8 to 1.9, to which is added a suitable quantity of arsenic. The ingredients of the bath are sulphuric acid of a specific gravity of about 1.84 and red-arsenic (As_2S_2) in the proportions of ¾ of a pound of red-arsenic crystals to one gallon of sulphuric acid. The castings may be either suddenly dipped in this mixture and then taken out and cooled in water, or they may be left



Cooling Tank and Hardening Bath for Cast Iron

in the bath until cooled. It has been found, however, that dipping the castings in the bath and holding them there for some time, which varies according to the size of the casting, and then completely cooling in water, is quite as satisfactory, and produces a material which is just as hard as if the castings were allowed to remain in the bath until cooled, and this method is preferable if a large number of castings are to be hardened, as the bath is thus prevented from becoming overheated. In preparing the bath, when sulphuric acid and red-arsenic are used, we find that better results are obtained when the crystals are added to the sulphuric acid and the bath is allowed to stand for about a week before using, the reason probably being that the bath becomes more saturated with the arsenious compound when the dissolved red-arsenic has been long in the sulphuric acid.

It is not necessary that the casting be machined completely before hardening, as rough finished castings may be hardened equally well. The change which takes place in the metal is in the nature of a molecular re-arrangement or re-crystallization coincident with an increase in the combined carbon at the expense of graphitic carbon, and in this change

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lies the difference between the results obtained by this bath and ordinary case-hardening processes, in which a certain portion of the carbon contained in the material of the bath is actually given up to the metal.

It is found that the more rapid the cooling of the metal, the harder it will become. For this reason the bath must be of high heat-conducting power, and this requirement is obtained by the use of the ingredients referred to. Furthermore, the bath must be practically free from water, as it is found that when the acid contains water in any considerable quantity, a steam cushion is formed between the acid and the metal which prevents their coming in contact, with the result that the cooling is less rapid, and, consequently, the iron is not so hard.

A cylindrical jar made of lead should contain the bath, the size varying according to the work to be done. A jar about 10 inches in diameter by 18 inches deep, will be about right for ordinary small work. This lead jar should be enclosed in an outer vessel through which water is caused to continuously circulate in order to keep it cool. It might be further pointed out that if it is desired to harden one portion of a casting and leave the remaining portion soft, this may be accomplished very readily by immersing only the part to be hardened.

Such a hardening equipment has proved very satisfactory in locomotive work for hardening bushings, etc., and many other uses could no doubt be found for it. The whole equipment can be homemade, consisting as it does simply of a steel tank divided into two compartments, and the lead jar for the bath, as shown in the illustration. The water circulates in the first chamber around the lead vessel, keeping it cool, and then passes to the second chamber, into which the castings are dropped, when taken from the bath, to cool off. The water then passes into the sewer or other suitable containing device. There is a screen placed in the second compartment to keep the castings from falling to the bottom. A lead cover should be made for the bath to keep the acid solution from evaporating, and a little care exercised by the workman so as to prevent the solution from splashing on him.

* * *

TIME OF EXPOSURE FOR DRY-PLATE PHOTOGRAPHY

In the January, 1909, issue of MACHINERY, engineering edition, an abstract was published of a paper on "Industrial Photography," by Mr. S. Ashton Hand, read before the American Society of Mechanical Engineers at the December, 1908, meeting. A contribution to the discussion on this subject was made by Mr. Charles W. Hunt, who submitted some interesting records of experiments made by himself for the purpose of estimating the proper time of exposure for dry-plate photography. The accompanying tables are based on this series of experiments. As a preliminary step, the altitude of the sun was calculated for each hour of the day from sunrise to sunset on the first day of each month of the year and the results plotted.

In June, 1905, a series of exposures was made with a Watkins exposure meter at each hour of the day, and a tentative table of the relative exposure time for each hour from sunrise to sunset was made. Using this tentative table, a series of similar exposures was made with dry plates. The plates were each developed the same length of time and in the same strength of developer. From these tests the tabular time was corrected. A table was then made giving the estimated time of exposure for each hour of the first day in each month in the year, basing the time of exposure largely upon the tests and the altitude of the sun in the different months. During the ensuing year this table was tested from month to month, and revised as experience indicated, in order to get the best attainable negative at any hour of the day in any month of the year. Table I is derived from the results of the above tests, with the formulas corrected to correspond with exposures made on Eastman films of 1908.

The time for a theoretically perfect exposure that will result in the best printing negative that the subject will give, cannot be expected from any formula that takes into consideration only the most prominent factors affecting the problem. These rules may, however, be expected to give a reasonably close approximation to a perfect exposure. In making exposures where it is unusually important to secure a good negative, and the exposure cannot be repeated, make three exposures as follows: The first exposure with time as computed; the second, with one-half the computed time; the third, with double the computed time.

For less important cases, but where great uncertainty exists as to the proper time of exposure, proceed as above, but make only two exposures, the slowest and the fastest, omitting the computed time exposure. The latitude of the plate will give a satisfactory negative if the theoretically perfect time of exposure lies within very wide limits.

An exposure should not be made in a fog, and in hazy weather only of nearby subjects. Good negatives may be made during a shower if the weather is otherwise clear. Generally, if contrast in the negative is desired, underexpose; if definition in the shadows is wanted, overexpose. When in doubt, it is safer to overexpose. Stops number 64 or 128 are excellent for general outdoor exposure; number 32 or 16, for indoor work. If it is desirable to emphasize a specific part of a machine, focus carefully with a large stop, and shorten the exposure to correspond with the stop.

TABLE I. COEFFICIENTS "A" FOR PHOTOGRAPHIC EXPOSURES IN THE LATITUDE OF NEW YORK

Month	Hour of the Day				
	7 to 8 or 5 to 6	8 to 9 or 4 to 5	9 to 10 or 3 to 4	10 to 11 or 2 to 3	11 A. M. 12 M. 10 P. M.
January-December...	..	2	4	6	7
February-November..	..	4	5	7	8
March-October.......	2	5	6	8	12
April-September......	4	6	9	12	16
May-August..	5	8	12	18	28
June-July...........	7	10	16	24	32

The following formulas and tables are based on normal light conditions and ordinary subjects. If either or both are abnormal, the operator must make allowance in the duration of exposure as computed by coefficients from Tables I, II and III:

TABLE II. WEATHER COEFFICIENTS B

Clear, sunshiny weather..........................	1.0
Floating, white fleecy clouds......................	1.0
Overcast, but a light day..........................	1.5
Cloudy, dull day	2.0
Lowery, heavy clouds..............................	4.0

TABLE III. SUBJECT COEFFICIENTS T

Shop interior, dark and poorly lighted................	1000.0
Shop machinery fairly well lighted..................	400.0
Shop machinery placed near a good window light......	150.0
Machinery under sheds with one side open, or covered areas	15.0
Machinery outdoors to give details in the shadows....	2.0
Machinery outdoors, general views....................	1.5
Groups or portraits outdoors.........................	1.0
Buildings and nearby landscape......................	1.0
Distant structures or landscape views................	0.5

Time Exposure

Assume a stop suitable for the subject and call it H; then the seconds to expose will be

$$\frac{H \times B \times T}{32 \times A} = \text{seconds exposure for an } H \text{ stop.}$$

Bulb Exposure

A "quick" bulb exposure is a time exposure of about 1/5 to 1/4 second. To compute the number of the lens stop, use the formula:

$$\frac{8 \times A}{B \times T} = \text{stop for a "quick" bulb exposure.}$$

* * *

A non-shrinking alloy can, according to the *Scientific American*, be made by melting together equal weights of tin and zinc. The alloy is hard when a good grade of zinc is used. Two parts of bismuth by weight to 50 parts of tin and 50 parts of zinc, will render the alloy very fluid and make it possible to pour it at a lower temperature.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

MILLING INDEX DIALS

The charts shown in the accompanying illustrations, together with the following explanation, show how a rather complicated job of indexing was simplified to enable an operator who was familiar with only plain milling operation, to carry on the work.

It will be observed by referring to the drawing of the dial, Fig. 1, that the index lines, notches and set-screw must be in a fixed relative position. An index plate with a 54-hole circle was selected, and the degrees between the notches and lines on the dial were reduced to turns and holes for each movement as follows: As it requires forty turns of the crank to make one complete turn of the work, there is, in this case, $40 \times 54 = 2{,}160$ holes to one turn of the work, and a movement of one degree equals $2{,}160 \div 360 = 6$ holes. It is now only necessary to multiply the number of degrees given on the charts by six, to get the number of holes for each movement, and then divide by 54 to reduce the movement to turns

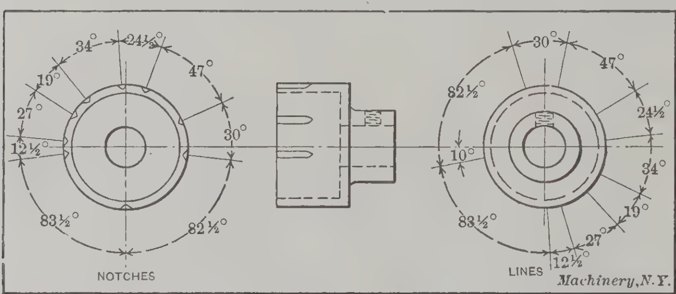
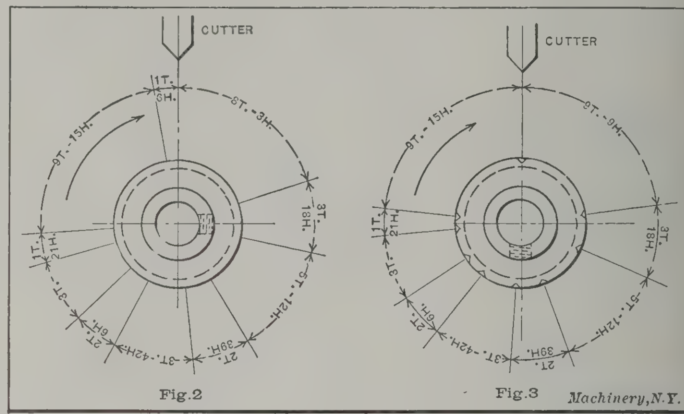


Fig. 1. Index Dial in which Notches and Lines are to be milled

of the crank and additional holes in the plate. For example, 10 degrees $\times$ 6 $=$ 60 holes, or 1 turn and 6 holes.

The work of milling the index lines and the index notches was divided into two operations to avoid confusion, and two charts were made as shown in Figs. 2 and 3. The lines were milled first, and in starting great care was exercised to get the center of the set-screw exactly on the horizontal center line, and to the right, as viewed from the hub end. Now by indexing ten degrees, or one turn and six holes, we are in position to mill the first line, the cutter having been previously set central. Then by indexing, in the direction of the arrow, the required number of turns and holes for each successive cut as indicated on the chart for milling lines, it is a simple



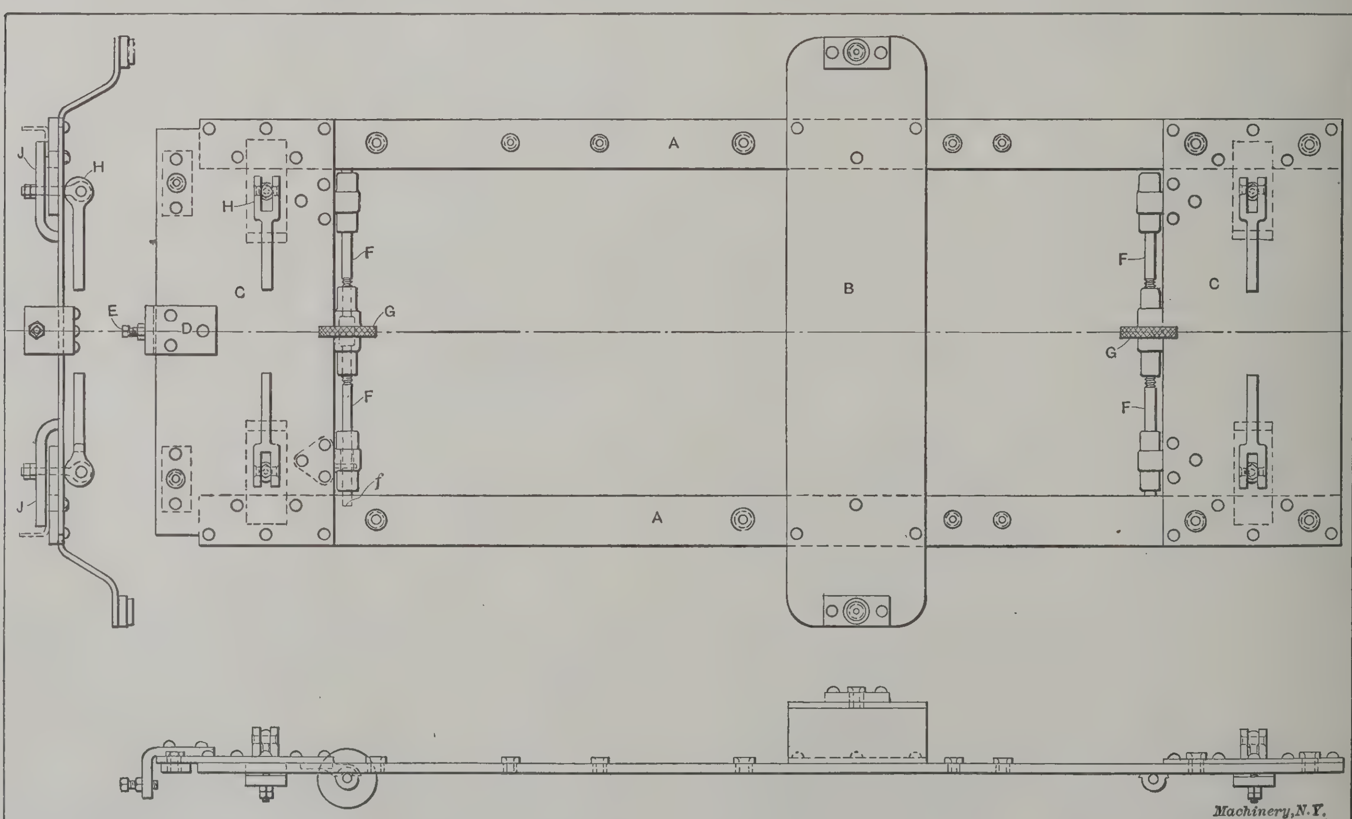
Figs. 2 and 3. Charts for Milling the Lines and Notches

matter to finish that operation. The work will then be in the original position. By referring to the chart for indexing the notches, it is found that one of them is in line with the set-screw hole. As this point makes a convenient starting place for the second operation, the work is indexed one-quarter turn or 90 degrees by ten turns of the crank. This brings the work in the proper position for starting the first cut. Then, by indexing in the direction of the arrow, as shown by the chart in Fig. 3 for milling the notches, the second operation is finished.

C. G. H.

JIG FOR DRILLING AUTOMOBILE FRAMES

A jig for drilling automobile frames is shown in the accompanying engraving. This jig is designed for drilling the holes for the motor and transmission feet, dash anchor plate, radiator, clutch, and shifting yoke holes, all at one setting. The frames, when received, are riveted and have all the holes drilled, except the ones mentioned.



Adjustable Jig for Drilling Automobile Frames

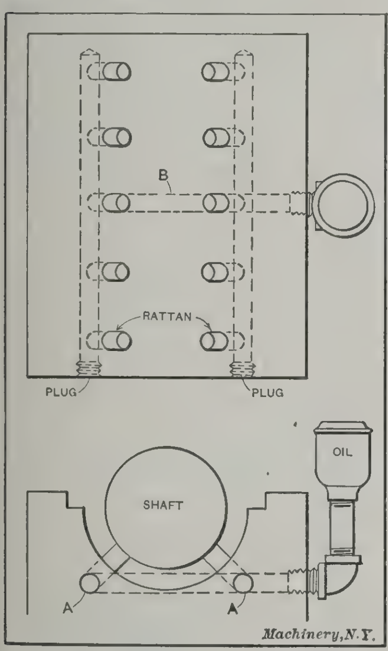
The jig, consists, principally, of two side members, *A*, made of ½ x 2½ inch machinery steel; one cross member *B*, made of ¼ x 7-inch machinery steel; and two cross members *C*, made of ¼ x 9-inch machinery steel. The parts are put together with 5/16-inch rivets. The bracket *D* is riveted to the front cross member *C* and it holds the jig in the proper position lengthwise. The screw *E* allows for adjustment. Bracket *D* is made of 1½ x 2½-inch machinery steel and it is riveted to the cross member *C*. The jig is centered by the four adjusting rods shown at *F*; the points *f* bear against the inside of the sub-frame. Adjustment is made by hand-nuts *G*, right- and left-hand threads being employed. Four eccentric levers *H*, in conjunction with the clamps shown at *J*, are used for securing the jig to the frame. After the various members were riveted together, the holes were laid out, drilled and fitted with hardened bushings. This jig proved to be light and accurate.

After experimenting with various styles of drilling machinery, the writer found an elbow bracket drill to be the most convenient and rapid.

Detroit, Mich. J. F. Richman.

SUPPORT FOR SHAFT WHEN BABBITTING

An excellent support for a shaft when babbitting, which may be used afterward for lubricating purposes, is made by inserting pieces of rattan in two rows of holes drilled in the casting, as shown in the accompanying illustration. The holes should be about ¼ inch in diameter, and the rattan cut long enough to support the shaft in the proper position. Two holes *A* should also be drilled lengthwise of the bearing to connect the bottoms of the holes in which the rattan pieces are inserted. The ends of these holes *A* are plugged as shown. After the babbitting is finished, a hole *B* should be drilled across the bearing to connect the oil cup with the supply channels *A*. When the shaft is in place and in motion, it draws the oil through the rattan pieces which wear eventually and which are always in contact with both the shaft and the oil in the supply channel below. This feeding action is due to capillary attraction combined with gravity.



Rattan Shaft Supports afterwards used for Lubricating

S. C. Smith.

BORING MILL INTERNAL GEAR REPAIR

A 10-foot boring mill table with a broken internal gear is shown inverted in Fig. 1. This table is of cast iron, and the gear was cast integral with it. The breaking of this gear was caused by a broken tooth which jammed in the pinion, causing it to break out a section of the large gear at each revolution. As a new table would cost $385 in addition to a probable delay of several weeks, it was decided to repair the old one, and this was done in the following manner: A locomotive tire was found that would finish approximately to the correct size, and there was also stock enough for an inner flange for bolting the finished gear to the faceplate. A 15-inch Dill slotter with a table graduated into 360 degrees, was used to cut the teeth. As there were 120 teeth in the gear, the table was moved three degrees for each indexing. While the teeth were being cut, the tire was fastened to an old driving wheel center, to which it had been fitted in the same manner as it was to be held in position on the boring mill table. A recess about ½ inch deep was turned in the wheel center,

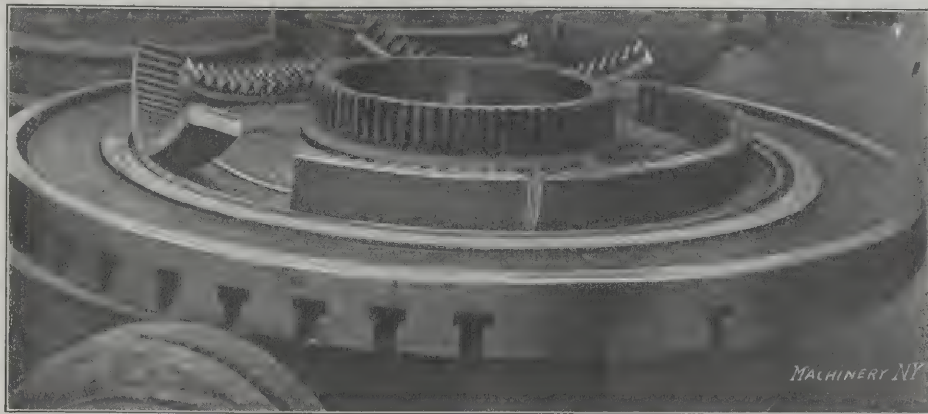


Fig. 1. The Boring Mill Table with its Broken Gear

and cap-screws were used to hold the work in place. The wheel center was also turned out on the under side to fit down over the outside of the slotter table. A roughing and finishing tool of the proper shape for the teeth was made to fit the slotter tool-bar, and the whole job was completed at a labor cost of less than $35. While this gear would probably not suit our friends, Mr. Grant or Mr. Bilgram, still it is doing the work for which it was intended, and is a fairly good job.

Battle Creek, Mich. M. H. Westbrook.

SUGGESTION DEPARTMENT IN THE SHOP

I would like to learn what the opinions of some of the readers of Machinery are on the merits and demerits of a suggestion department in shops, such as many stores and manufacturing concerns have, where prize money is paid to employes for suggestions submitted by them and adopted by the concern, that will be of value. I think that it is a good

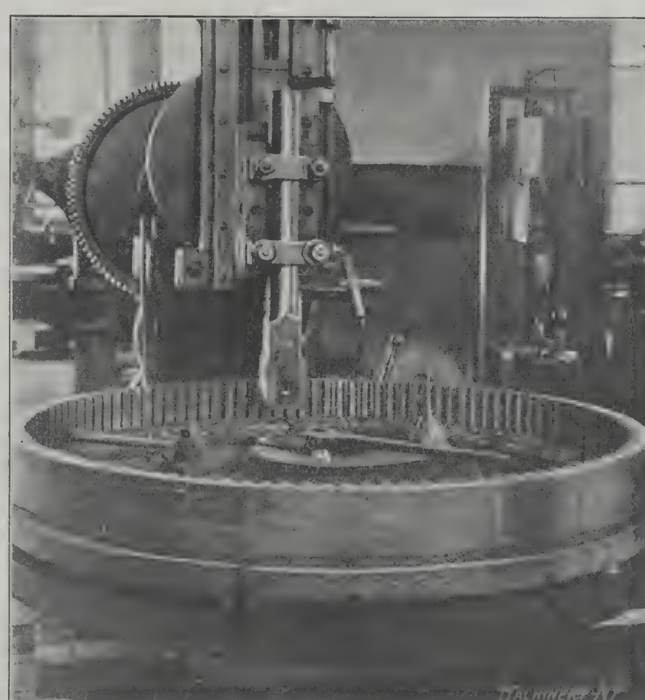


Fig. 2. New Gear being made from Old Locomotive Tire

thing if good sense and judgment are exercised in submitting the suggestions; and if conducted properly, it is an important factor toward the goal of commercial supremacy. I know of a number of highly prosperous concerns who acknowledge that much of their success is due to the suggestions submitted by their employes through the suggestion department.

Encouragement to employes from a concern for suggestions induces men to take an interest in their work and in the welfare of their employer. The ability of each man whose support is enlisted is also developed. Men engaged in a line of work day in and day out are often more likely to see the need of an improvement, than the foreman or superintendent.

When a suggestion is submitted by an employe through the suggestion department, he and not the foreman receives the credit for any improvement. A superintendent or foreman who is opposed to and refuses to accept or encourage suggestions from his men for improvements on a method or process, whether the suggestions come through a department or not, is, more than likely, impelled by jealousy and conceit and is burdened with an exaggerated sense of his own importance and ability. Obviously, such men should not be entrusted with important positions, as they are not qualified for the handling of men and the affairs of a concern. If a superintendent or foreman does not like to have it known that men under him can improve on his methods or system, it should spur him to so improve them that there will be no chance or room for suggestions.

Peoria, Ill. ARTHUR Z. WOLGAMOT.

LOCATING WORK WHEN BORING IN THE MILLING MACHINE

It often happens that accurate boring, drilling and reaming must be done on jigs, dies, fixtures, etc., in a milling machine, that cannot be relied on as to the accuracy of the measurement indicated by the adjusting screw dials because of lost motion between the screw and the nut. By the following method, the most rundown milling machine can be used for such work, and accurate results secured.

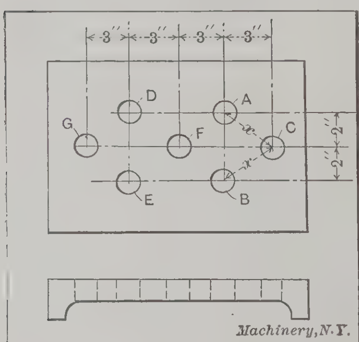


Fig. 1. Jig-plate to be bored as indicated

A jig-plate is represented in Fig. 1 that is to be drilled and bored for jig bushings as indicated. This will serve to illustrate the method of setting work on a milling machine that cannot be relied on. It is assumed that the plate is finished on the edges, and that it is fastened to an angle-plate, which is secured to the table and set square with the spindle. A piece of cold rolled steel or brass is first fastened in the chuck (which is mounted on the spindle) and turned off to any diameter. This diameter should preferably be an even number of thousandths to make the calculations which are to follow, easier. The turning can be done either by holding the tool in the milling machine vise, as shown in Fig. 2, or by securing it to the carriage with clamps. In either case, the tool should be located near the end of the table, so as to be out of the way when not in use.

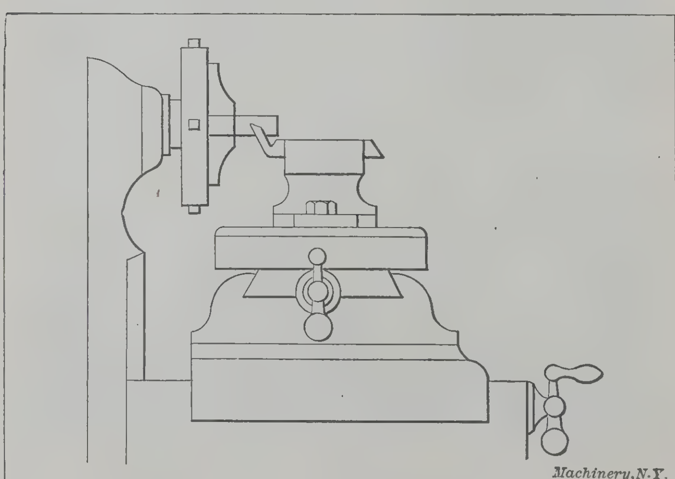


Fig. 2. Turning Plug used for Setting Jig-plate

After the piece in the chuck is trued, the table and knee is adjusted until the center of the spindle is in alignment with the center of the first hole to be machined. This setting of the jig-plate is accomplished by measuring with a micrometer depth gage from the top and sides of the work to the turned plug as illustrated in Fig. 3. When taking these measurements, one-half the diameter of the plug in the chuck is, of course, deducted. When the plug is properly set, it is removed from the chuck and the first hole A is drilled and bored or reamed to its proper size. The plug is then again inserted in the chuck and trued with the tool. After which it is placed in alignment with the second hole B; this is done by inserting an accurately fitting plug-gage in hole A and measuring from this gage to the turned piece in the chuck with an outside micrometer as in Fig. 4. Allowance is, of course, again made for the radii of the two plugs. The horizontal measurement can be taken from the side of the work with a depth gage as before. The plug is then removed and the hole drilled and bored to the proper size. Without changing the adjustment, the plug is again inserted in the chuck and turned true; the table is then moved vertically to a position midway between A and B, and then horizontally to the proper position for hole C as indicated by the depth gage from the side of the work. The location can be verified by measuring the center distances x with the micrometer. In a similar manner holes D, E, F and G are accurately located.

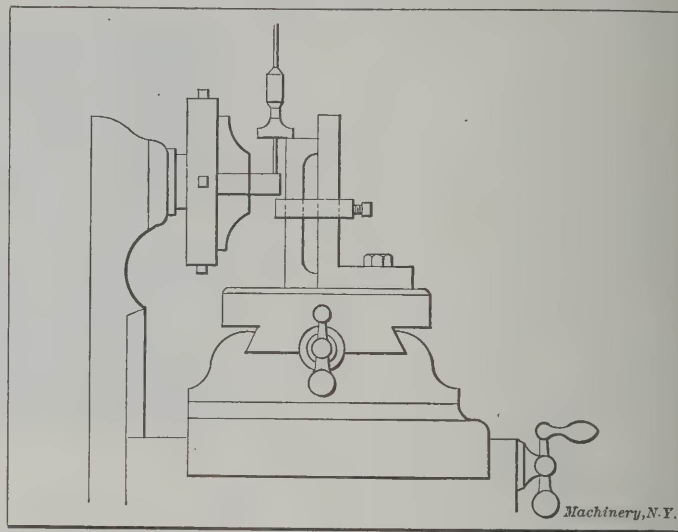


Fig. 3. Setting Jig-plate by measuring to Turned Plug with Depth Gage

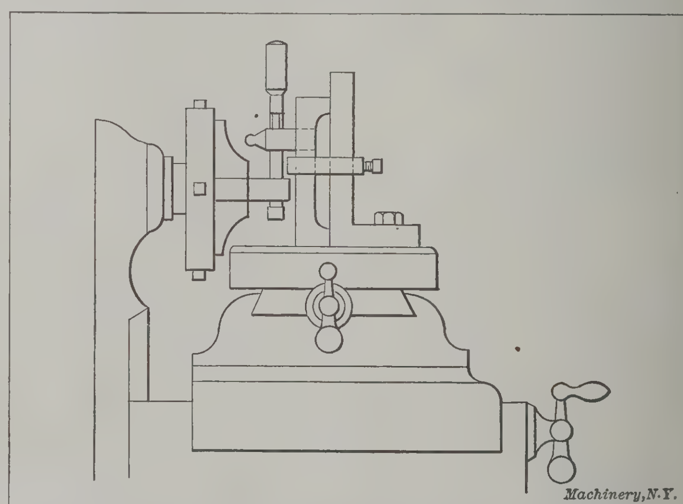


Fig. 4. Obtaining Accurate Center-to-center Distance by the Use of Plugs and Micrometer

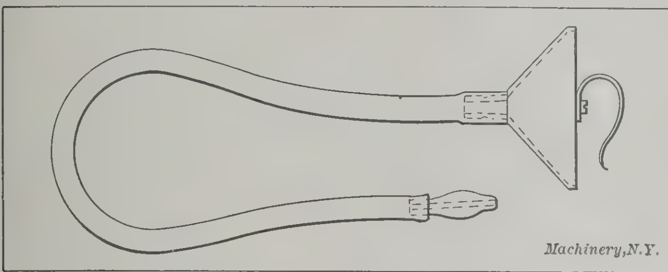
If the proper allowances are made for the variation in the size of the plug, which, of course, is made smaller each time it is trued, and if no mistakes are made in the calculations, this method is very accurate. Care should be taken to have the gibs on all sides fairly tight at the beginning, and these should not be tightened after each consecutive alignment as this generally throws the work out a few thousandths. If the reductions in the size of the plug, each time it is turned,

are confusing, separate pieces can be cut off and trued up to one side. If the center distances x are not given, it is, of course, far more convenient to make all the geometric calculations before starting to work. L. E. KRAMER.

Newark, N. J.

MECHANICS' STETHOSCOPE OR SOUND TRANSMITTER

The engraving shows how a simple stethoscope or sound transmitter is made. Its use is adapted to small work and particularly to bench lathe boring, grinding or lapping. It is composed of a piece of ¼-inch rubber tubing with a hard rubber ear-piece and a conical brass cup with a thin steel disk for a diaphragm soldered to the large end. In addition, there is a spring clip fastened to the diaphragm with a screw. Suppose a small hole 0.015 inch in diameter is to be lapped;



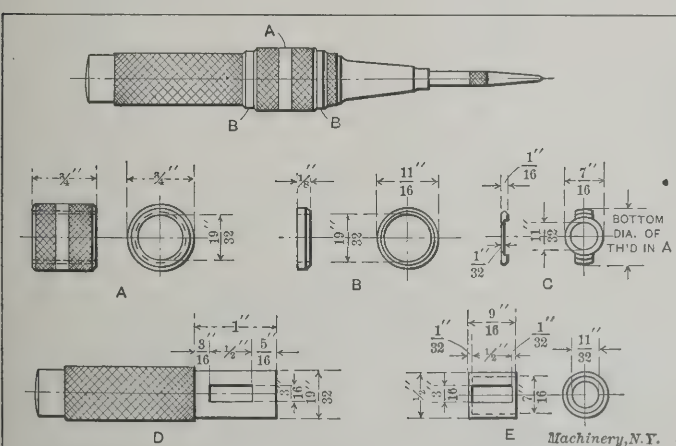
Simple Instrument for Transmitting Sound

then the spring clip on the diaphragm is slipped on the outside of the spindle bearing in which the lap is being used, and as soon as the lap is set in motion and adjusted, the finest touch can be detected with this instrument. I have seen many mechanics use the cover of a round tin box with a wire rod soldered to it. This transmits the sound fairly well, but the operator must hold his head in one position to listen, whereas the instrument shown in the sketch, because of the rubber tube, allows the operator to hear and also move so he can see what he is doing. A. J. DELILLE.

Elgin, Ill.

ADJUSTMENT FOR AUTOMATIC CENTER PUNCH

The following article describes an adjustment which may be fitted to a Brown & Sharpe plain automatic center punch. The advantages claimed for it are, a wider range of adjustment and the absence of projecting nuts on the ends of the



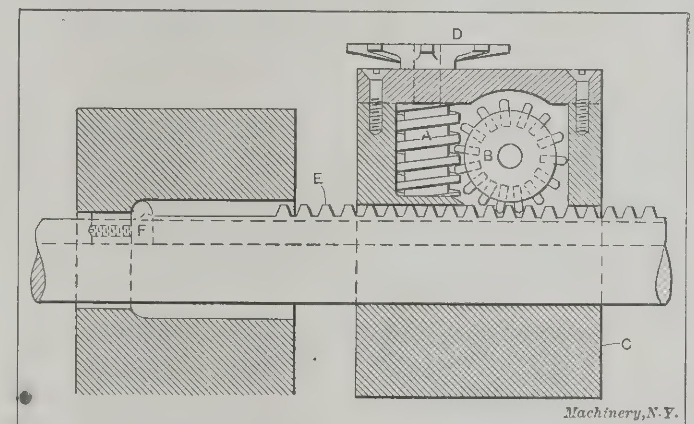
Parts for Making a Plain Automatic Center Punch Adjustable

punch. Its range of adjustment is from the full stroke of the punch down to no movement at all, as the release of the striking block is made adjustable, instead of the compression, on the spring.

At the top of the accompanying engraving the punch is shown assembled, and I do not think that it loses any of its neatness by the addition made to it. Parts A, B, and C are the extra parts required. The handle D is turned down on the end as shown, and two slots are cut through. Two slots of the same size are also cut in thimble E, so that when it is in position inside the handle, these slots are in line. Knurled sleeve A is bored to fit over the end of handle D, and it is threaded inside, 16 threads per inch, V-thread. A nice smooth thread is required. Collars B, of which two are needed, are merely to keep sleeve A from screwing up on the knurled handle, as the shoulder is so small. Part C is made a nice sliding fit inside of thimble E, and the two projections pass through the slots in E and D. The ends of these projections are bevelled to fit the thread inside of A, so that, when the parts are assembled, and the sleeve A, which is fixed endways, is revolved, the part C moves up or down inside of E. The bore of part C is the same as the bore of the inside flange on thimble E, this flange releasing the striking block. It is obvious that by revolving sleeve A until part C is at the bottom, the center punch is practically solid. When part C is at the top, the stroke is practically the same as in the plain center punch, and any stroke between these limits can be obtained. T. H. N.

SPECIAL BORING TOOL

We ran up against a snag at one time which made it necessary to design a special boring head and tool, and as the tool worked so satisfactorily I consider it entitled to a brief description in MACHINERY. This special tool was made necessary by a cored bearing which had to be bored, as there was no room around the shaft for babbitt. This shaft was fixed so that we could not get an end movement (or feed), and the bearing was also fixed, but we could drive the shaft by power when it was applied.



Special Boring Head and Tool

The accompanying illustration shows the construction of the special boring head used. It was made as cheaply as possible, and the parts were obtained from every available source. The worm A was taken from an old S-wrench, and the body C was made from a piece of scrap shafting. The cavity in which the worm A and wormwheel B were inserted, was cut with an end mill of practically the same diameter as the worm. This wormwheel was also made from a piece of scrap shaft, cut the right length to fit into the chamber. The teeth were formed by driving pieces of drill rod into holes drilled for the purpose. The part D is an eight-pointed star wheel, which was used for feeding the bar at each revolution of the shaft. The rack E was made from a piece of common key stock, of a size to fill the spline which happened to be in the shaft. The boring tool F was inserted in a hole in the end of the rack, and secured with a headless set-screw which allowed for adjustment. After the job was finished, it was found that by making two sets of brackets to support the ends of a permanent bar which was made to suit the head C, this tool could be used in many an out-of-the-way place, especially on repair work. H. E. WOOD.

Newark, N. J.

MAKING ACCURATE AUTOMOBILE ENGINE PISTONS

In a large shop that was turning out a great number of automobile parts on contract, they had trouble in getting accurately finished pistons, and after trying several different plans, the following was found to be most satisfactory.

Fig. 1 represents a chuck which is made of two gray iron parts; namely, the body A and the closing ring B. The body

was screwed on the spindle of an engine lathe by a spanner wrench which engaged the holes *C*. Fig 2 represents the finished piston. These pistons after having been entirely machined, except grinding, were placed in this chuck and a fine finish cut was taken in the mouth. When the piston was placed in the chuck, closing ring *B* was screwed tight by a spanner wrench which engaged holes *D*. The ring being a good fit at *H*, remained true when drawn back by the threads; and as the chuck body *A* was beveled to match the closing ring and saw-divided at *E* into three equal parts, it closed tightly on the piston and held it true so that the finish cut was true to the outside of the piston.

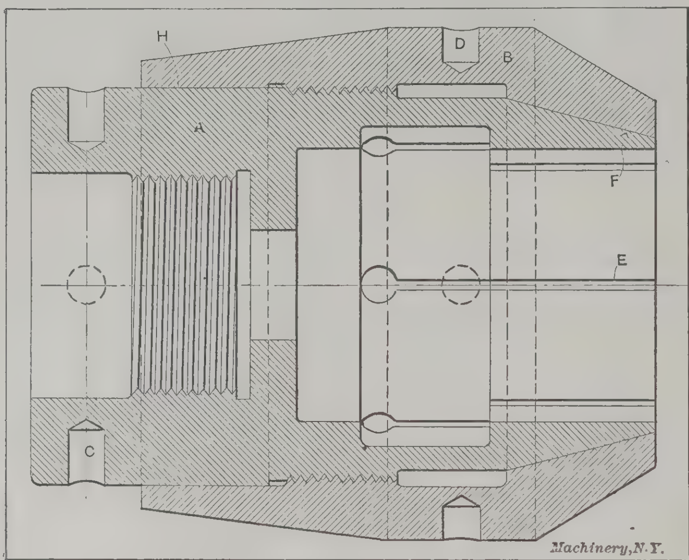


Fig. 1. Chuck for Holding Pistons while Boring Mouth

The cross bore in pistons which had previously been machined in a jig that fitted the outside diameter of the piston was, therefore, at right angles to the finished outside. Thus the cross bore, the mouth bore, and the outside diameter were made exactly true to each other. This much being accomplished, the finish grinding was made perfect by the mandrel shown in Fig. 3. This consists of a finished forging *J*, a pin *K*, that is a close fit in the cross bore of the piston and in forging *J*, and a cylindrical part *L* that is fitted accurately to the forging *J* and that also is a close fit at *O* in the finished mouth of the piston. By tightening nut *M*, shoulder *P* is brought square against the end of the piston. It is now evident that with the piston center on one center of the grinder, and the centered end of forging *J* on the other grinder center, with pin *N* acting as a driver, that an accurately ground piston would be the result. We found this method a little slower than some others, but the extreme accuracy obtained and the small number of pistons rejected by the inspectors, made the gain all in favor of the fixture.

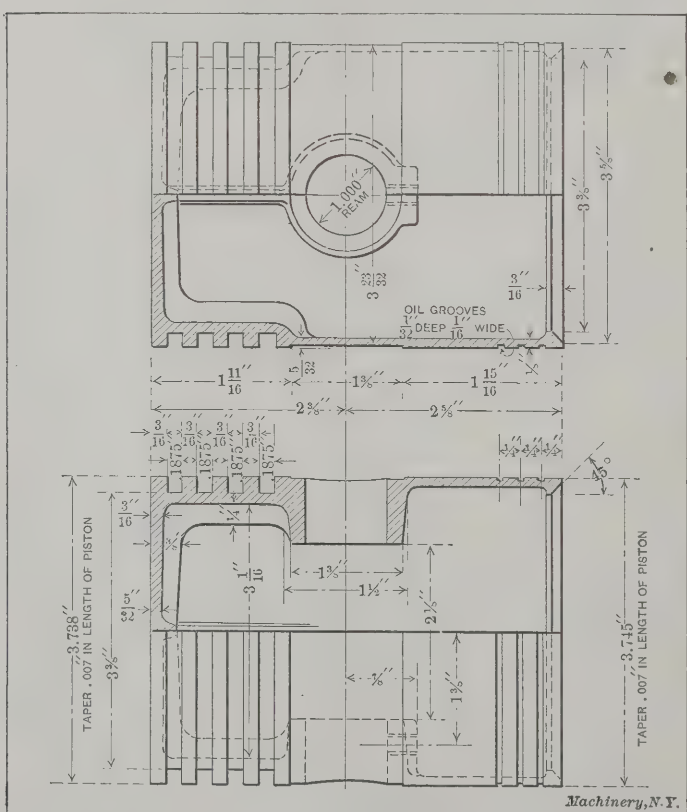


Fig. 2. Automobile Engine Piston

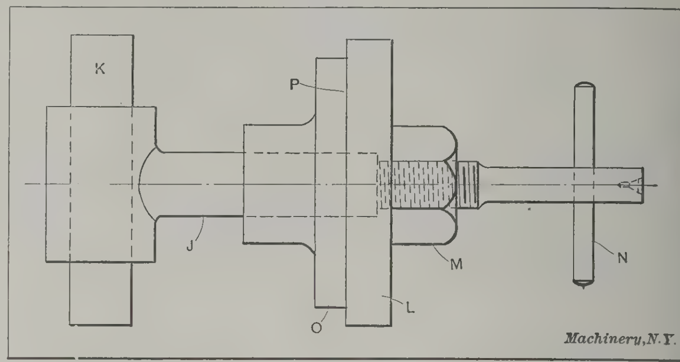
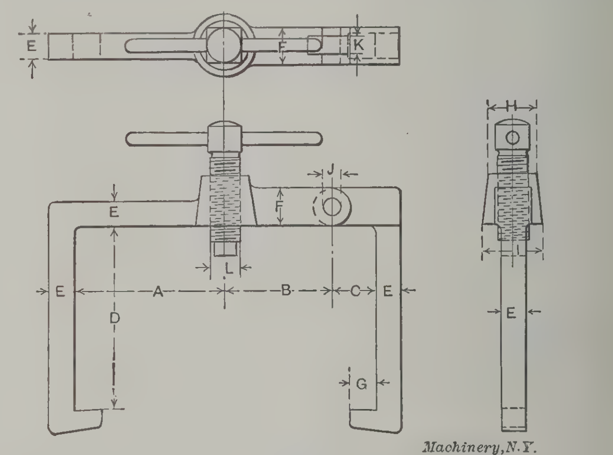


Fig. 3. Mandrel on which Pistons are held while being ground

JIG AND TOOL DESIGNER.

HANDY SET OF CLAMPS

We had some work to clamp in a drill jig, and as the ordinary C-clamp required too much time to operate, the type of clamp shown in the accompanying illustration was designed. A common squared-head cap-screw with a dog point is used to tighten the clamp after the movable side is swung into place. A ¼-inch pin, 3 inches long, passes through the head of the clamping screw, which makes it unnecessary to use a wrench for tightening. The swinging side of the clamp is pivoted to the main part by a pin which passes through a hinge fitting, as shown. Dimensions for four different sizes of clamps of this type are given in the table below the engraving. These clamps are very convenient, quick-acting, and they may be used for many purposes.



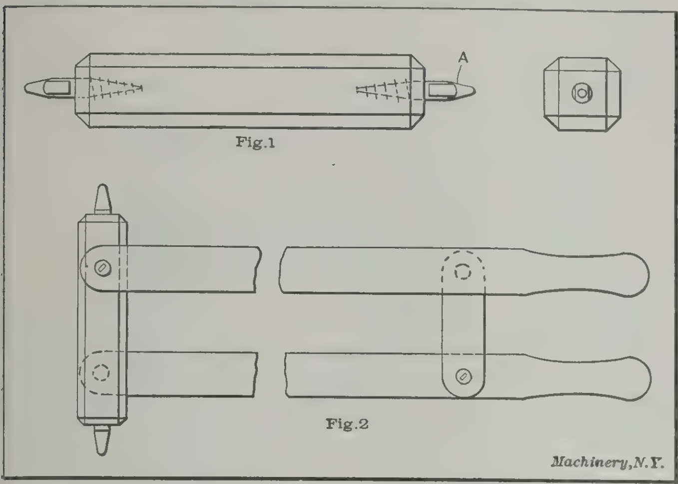
Size No.	A	B	C	D	E	F	G	H	I	J	K	L
1	3	$2\frac{1}{8}$	$\frac{7}{8}$	$2\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{9}{16}$	1	$1\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{8}$
2	3	$2\frac{1}{8}$	$\frac{7}{8}$	$2\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{9}{16}$	1	$1\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{8}$
3	$1\frac{7}{8}$	$1\frac{1}{4}$	$\frac{5}{8}$	$1\frac{3}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{9}{16}$	1	$1\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{8}$
4	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{3}{4}$	$2\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{9}{16}$	1	$1\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{8}$

E. H. PRATT.

DEEP HOLE CALIPERS

In response to the editor's request, in the December number, for descriptions of deep hole calipers, I submit the following and the accompanying sketch, as a possible solution of "J. W. M.'s" problem. Fig. 1 represents a point or inside caliper similar to those used in the U. S. arsenals on large gun work. The body of the caliper or "stick," as it is called in the shop, is made of a piece of wood, and the points *A* are made from wood screws, the heads being cut off and the body

turned down as shown. Two flat places are filed on each point so that a wrench may be applied to adjust the points in or out for any required size within its limits. These sticks have many advantages over the usual methods of obtaining inside measurements: They are easily adjusted to outside micrometers or verniers and it is only a few minutes' work to make one of any desired length; the wood acts as an insu-

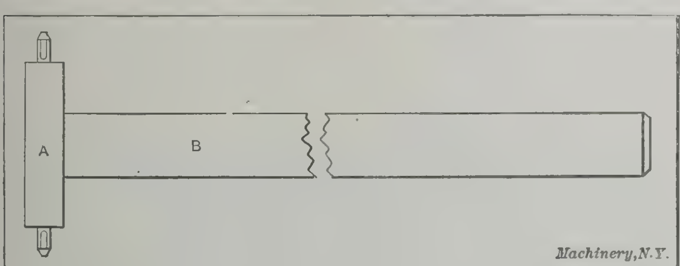


Figs. 1 and 2. Inside Caliper and Same Tool with Handles for Deep-hole Work

lation from the heat of the hand and furnishes a convenient place on which to mark the size to which it has been or is to be set in the inspection department. Fig. 2 shows how I would rig up one of these sticks to caliper the size at the bottom of a deep hole such as J. W. M. mentions, and with it I believe it would be an easy matter to ascertain the size within 0.00025 providing, of course, an outside micrometer of the required size is convenient. However, if the pieces are to be measured in large quantities, a star gage would be much quicker. T. COVEY.

DEEP HOLE CALIPERS

Through the "How and Why" page of the December, 1909, number of MACHINERY, J. W. M. asks for the best means of accurately determining the size at the bottom of a bore approximately 4 inches in diameter and 12 feet long. The best and cheapest way of measuring the diameter that I know of, is to take two wood screws, cut off the heads, point them,



Improved Deep-hole Caliper

file a flat on each side of the body so that they can be turned with a wrench, and screw one in each end of a piece of wood *A* about ¾ inch square by 3 inches long. A wooden handle *B* of the required length should be attached to the center of the cross-piece *A*, thus forming a T. The flats on the screws make it easy to adjust them in or out until they are set to the diameter of the work. Of course, the caliper must be withdrawn each time an adjustment is made.

Poughkeepsie, N. Y. GEORGE H. DESROCHERS.

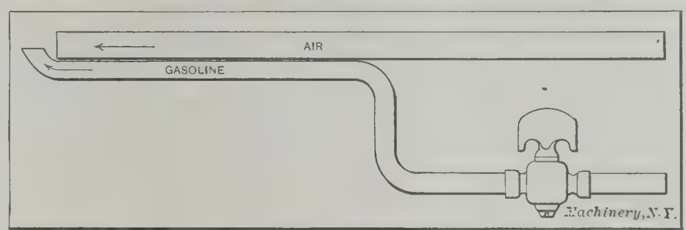
CENTERING A SHAFT WITH A MILLING CUTTER

The method of centering a shaft with a milling cutter when key-seating, described by Mr. H. E. Wood in the October number, is a very good one, and one that I have used many times. It is also a good way of centering work with the cutter when milling spirals. By this method the centers can be set central with the cutter before swinging the table to the angle of the spiral. Another good method of centering the cutter when milling spirals, is to set the pointer of a surface gage to the height of the center, and then scribe a line across the end of the work, which is then indexed a quarter turn so as to bring the scribed line in a vertical position. The cutter may then be set with reference to this line. Still another method I often use when key-seating is as follows: The shaft is first adjusted so as to bring it within a few thousandths of being against the side of the cutter; then, if the cutter runs out laterally, it can easily be detected by sighting down over it while it is revolving. With the cross feed, the shaft is then set so that it just touches the side of the cutter. If the latter runs out of true, that part which is midway between the two points that run out the most should be set against the shaft. The dial on the screw is then set to zero; the table is locked, and the shaft is moved in a distance equal to one-half its diameter. The side of the cutter will then be in the same vertical plane as the center of the shaft. The dial may then be again set to zero so that the work may be moved a distance equal to one-half the cutter width. The shaft will then be exactly central with the cutter. ARTHUR Z. WOLGAMOT.

Peoria, Ill.

CLEANING AUTOMOBILES

As a foreman and mechanic in the automobile industry, I have been called upon many times to repair very dirty machines, a job which is sometimes annoying to the men. The device shown in the accompanying illustration has been found very effective for removing the dirt from automobiles, and it doubt-



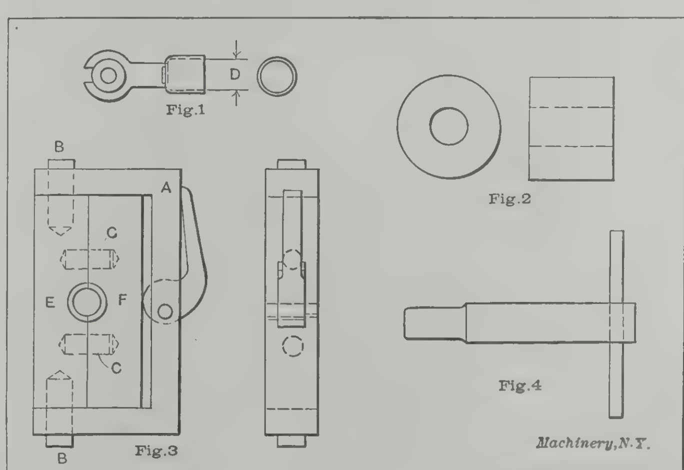
Air and Gasoline Nozzle used for Cleaning Automobiles

less would prove useful in connection with other work. This device consists of an air and gasoline nozzle, which is made of two pieces of tubing about fifteen inches in length. The sizes of these tubes are ⅜ and ¼ inch for the air and gasoline, respectively. Care should be taken to make the end of the gasoline pipe come exactly central with the air outlet, as shown in the illustration. By means of hose, one nozzle is connected with the compressed air and the other to a gasoline can. A valve can be placed on the gasoline pipe to regulate the amount of gasoline to be used. With a heavy air pressure, one gallon of gasoline will clean an entire automobile very effectively in an hour or so, and better than by any other method known to the writer. J. B. KEMP.

Indianapolis, Ind.

DIE FOR REDUCING MAGNETO CABLE ENDS

A handy fixture is shown below, which the writer had occasion to use for re-forming the spark-plug end of magneto cables used on automobile engines. Magnetos with cables were bought from one company, and after some time a change



Figs. 1 to 4. Die for Reducing Spark-plug End of Magneto Cable and Sample of Work

was made in the cables and it was found that the new cables were 1/16 inch smaller in diameter. As a result, the terminal for the spark-plug end of the cable was too large and scraping this piece was out of the question, as this would involve considerable delay, which at the time could not be tolerated. In Fig. 1 is shown the cable end, the diameter *D*, being, as before stated, 1/16 inch larger than required. Fig. 3 shows the die for reducing the diameter. This die was split in order to be able to place the work into it. The part *A* of the die was pivoted on the pins *B* which were fastened into the half of the die marked *E*. The other half of the die was held by the eccentric which pivoted in *A*, the pins *C* locating this half. Fig. 4 shows the punch, and Fig. 2, a guide for the punch. This work was done by a boy, in a small hand press. After the piece was forced through the die and reduced, it was trimmed on the end, this being necessary because of the redrawing of the metal.

St. Louis, Mo. C. T. SCHAEFER.

EFFICIENT TYPES OF MILLING FIXTURES

With reference to W. A. Sawyer's "Efficient Type of Milling Fixture," illustrated and described in the October number of MACHINERY, in the Letters Upon Practical Subjects department, I would like to offer a little friendly criticism. I consider that there are at least three weak points in the design, *viz.*, (1) Work is not properly clamped. (2) Fixture is hard to keep clean. (3) Fixture is slow to operate.

To prove the claims—First, the work is clamped on one side of the cutter only and there is nothing to prevent the cutter from lifting the unsupported side at the beginning of the cut, unless the operator is very careful in advancing the work to the cutter. Again, if the work is not of a uniform thickness, one piece will be clamped close to the cutter while the other is clamped at some distance from it. The engraving Fig. 1 will serve to illustrate this.

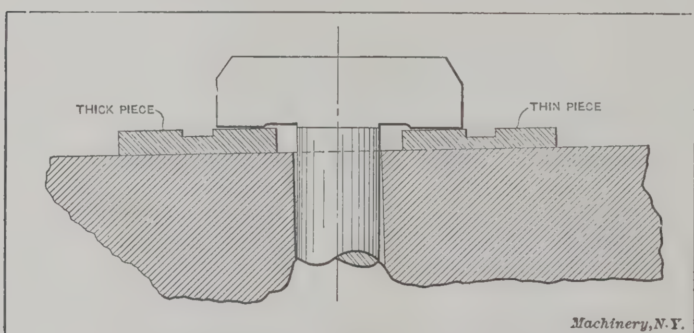
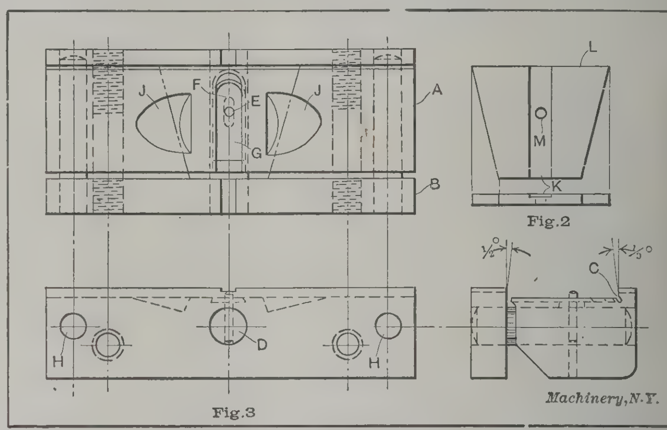


Fig. 1. Pieces of Different Thicknesses held by a T-clamp

Second, to clean the fixture it must be taken apart, and this the writer considers a bad feature in fixture design, unless the construction is very simple. Any one studying Mr. Sawyer's design and noting the number of moves required to clean the fixture, will admit that the time required for cleaning is long compared with the time required to perform the cutting operation. I am, of course, assuming that Mr. Sawyer's sketch is proportional. The clearance slot for the pin *C* is unprotected from chips during the cleaning operation, and, in time, would become choked up. The foregoing objections would also apply to the third weak point, since it cuts down the output. It would be interesting to know what the latter would be per hour.

If a reliable vise is available, a pair of vise jaws could be made similar to Fig. 3 which would perform the operation satisfactorily. Jaw *A*, which is stationary, supports the work to within 1/32 of an inch of its width. *B* is a plain jaw. A slight angle of about ½ degree is given to the faces of both jaws to insure the work being held securely at the upper edge. A slight clearance check or groove is cut at *C*. *D* is a sliding pin which is an easy fit in both jaws. Into this pin is inserted pin *E* which locates the work. This pin is free to slide in jaw *A*, while slot *F* is protected from chips by means of a sheet metal piece *G*, which is dovetailed into *A* and slides with pin *E*. Clearance cuts *J* assist in lifting the work from the jaw. Lining pins *H*, which are driven into jaw *B* and slide in jaw *A*, prevent any lifting effect when tightening the vise.

It will readily be seen that a design of this type will embody what the writer considers the five most important features in fixture design, *viz*: Simplicity, efficiency of clamping device, ease with which it is cleaned, quickness of operation, and durability. A design such as is suggested would not cost more than 25 per cent of the cost of Mr. Sawyer's fixture, and while it is only a single fixture, there is very little time saved in making it multiple, as the cut is comparatively short and shallow and the time saved by being able to remove work and brush away chips quickly will more than counterbalance the advantage of milling two pieces at once; thus the output would be greater than with a fixture of Mr. Sawyer's design.



Figs. 2 and 3. Work and Fixture for Holding it while Groove "K" is being milled Square with Edge "L" and Central with Hole "M"

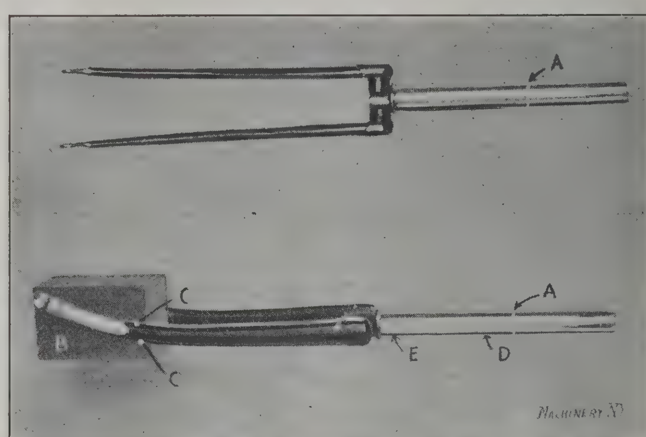
If a suitable vise is not available, a special vise with cam movement could be made at small cost to take a pair of jaws of the above type. The jaws can also be case-hardened and ground, thus adding greatly to their life. Where conditions will warrant the expense, and the output is increased, special fixtures are often advisable. Nevertheless there are many cases like the foregoing, where vise jaws will not only be cheaper but better in other ways.

Montreal, Canada. IRWIN JENKINSON.

TURNING A BICYCLE FORK

As the fork of my bicycle was broken, I tried one from an old wheel to see how it would fit, and found that it was suitable in every respect except the length of the stem, which needed to be cut off at *A* and be re-threaded. This work was done without difficulty by the following method: A block of wood *B* was fitted in between the tines of the fork and was held rigidly by a bolt which passed through the tines and block. It was further secured by wire nails driven in at *C*. The fork was then placed in the lathe, the block of wood giving a good center for the live center of the lathe. After the steady-rest was placed at *D* the stem was easily cut off. The steady-rest was then changed to position *E*, the end of the work was supported by the dead center, and the thread cut, thus completing the job. STEPHEN COURTER.

Paterson, N. J.



Bicycle Fork with Block fitted between Tines to permit turning in the Lathe

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

COLBURN "NEW MODEL" BORING AND TURNING MILLS

The Colburn Machine Tool Co., of Franklin, Pa., has developed a line of boring and turning mills, which we herewith illustrate and describe. The name "New Model" is used to designate this design. In its general lines it does not differ from the older designs of the same builders but there have been important improvements in detail made throughout which materially increase its convenience and capacity. There are five sizes in the entire line, these being 42-, 48-, 50-, 60- and 72-inch swing, respectively. Practically the same features are incorporated in all the sizes, and a description of any one size applies to the rest. The illustrations here shown are mostly taken from the 60-inch machine.

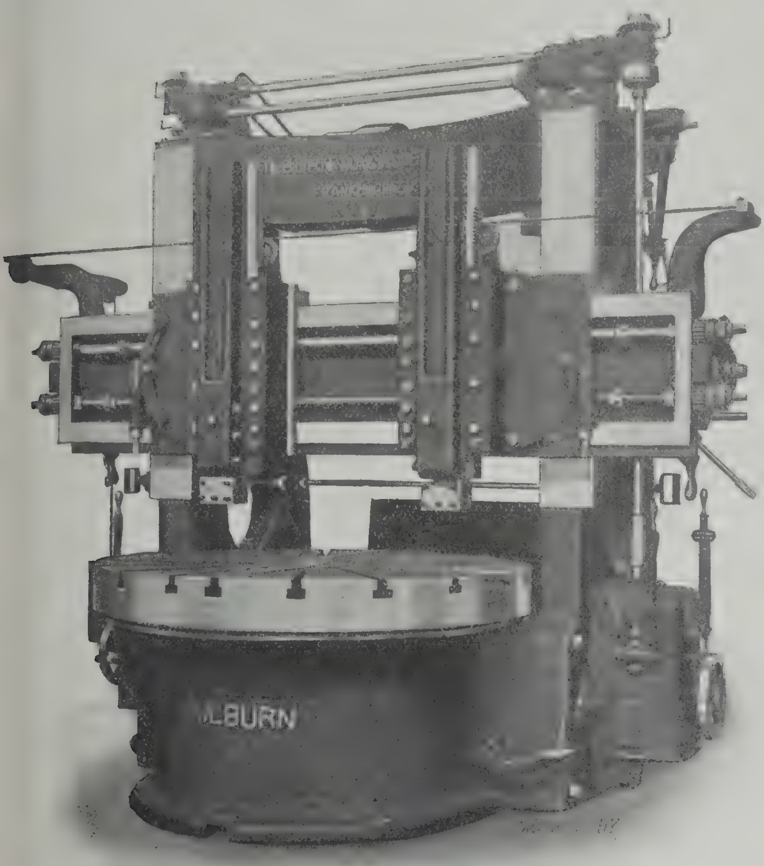


Fig. 1. "New Model" 60-inch Colburn Boring Mill

The main framework of the machine is of standard construction as may be seen from the illustrations. The parts have been carefully designed to permit the taking of heavy cuts without vibration or deflections. The cross-rail, in particular, has been strengthened, having been given a heavy arched box section which is exceedingly rigid. The saddles have unusually liberal bearing surfaces on the cross-rail, with adjustable taper gibs to compensate for wear. The swivels, which are of large diameter and ample bearing area, are provided with an angular adjustment by means of a worm and gear, which also acts as a positive locking device making it impossible for the heads to accidentally fall over sideways when the clamping bolts are released. The ram (see *A*, Fig. 9) is very massive and has a steel rack set into its side. The cored opening is extended all the way to the top so that extra long boring-bars can be used. Clearance is provided to permit the rams to be raised within the guides.

The Main Spindle and Drive

Figs. 3 and 4 show clearly the construction of the spindle and the table drive. The spindle *A* has a massive angular thrust bearing which makes it self-centering. This, in conjunction with the two large cylindrical bearings *D*, effectually resists vertical, angular and horizontal strains. All these surfaces are lubricated from a common supply, this being the oil bath in which the angular bearing revolves. The lubricant is kept at the proper height by the oil gage and filler at the side of the base, connected to the spindle bearing by piping as shown in Fig. 3. The constant flow of oil along the conical thrust surface of *A* is maintained by the motion of the spindle. The lower part of the bearing is immersed in the reservoir of oil *B*, which is carried upward to the outer edge of the bearing and into the annular channel there, from which it is returned through suitable grooves to *B* again. By this means the bearing is automatically flushed, and the oil flows over into the cylindrical bearings. A circular safety pad of felt *E* contains enough oil to keep the cylindrical bearings *D* from becoming dry, even if the supplying of the reservoir is neglected for a long time.

The table is driven by a spur gear *F* of large diameter, attached directly to it. No lifting tendency is possible with this style of drive. As shown in Fig. 3, an internal gear is used on the 60- and 72-inch mills, while an external gear, as shown in Fig. 4, is used on the three smaller sizes. The table pinion *G* is mounted on a vertical shaft, which is oiled by a suitable reservoir and wicking as shown. In this case, as in the other important bearings, care is taken to provide a design which will give satisfactory lubrication, even though the oiler neglects the machine for continued periods.

The Speed Changing and Controlling Mechanism

The drive is by means of 5-step cone pulleys of large dimensions connected through a speed or back-gear box with the horizontal shaft carrying bevel gears

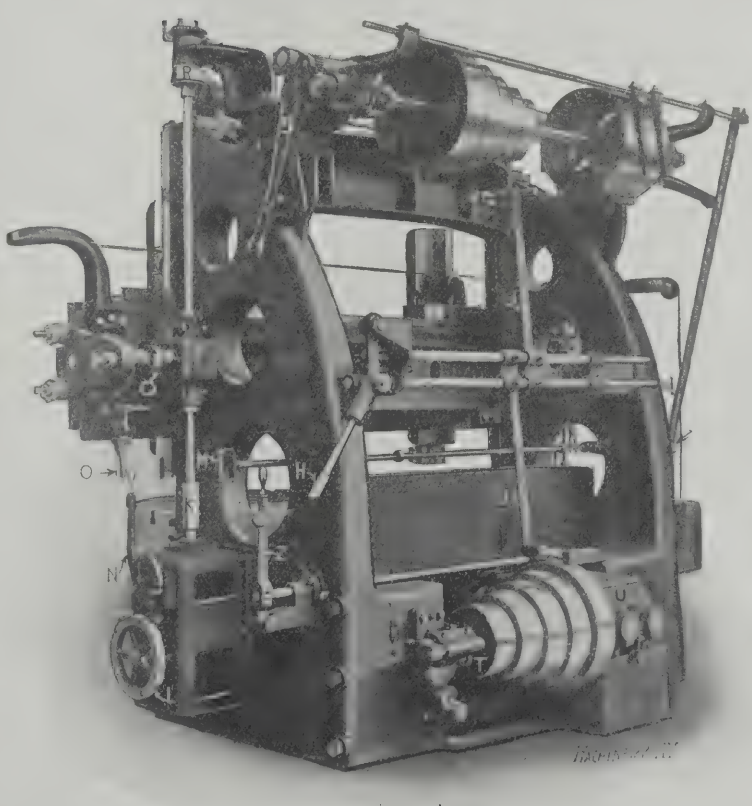


Fig. 2. Rear View of "New Model" Boring Mill, showing Main Drive Controlling Handles, Levers, etc.

meshing with the vertical table pinion shaft shown in Fig. 4. The driving arrangement is best shown in Fig. 2, while details of the back-gear mechanism and the speed box are shown in Fig. 5. A belt shifter is shown which is simple, effective and easily operated, and avoids the necessity of the complicated mechanism and multiplicity of parts used on many geared speed-changing arrangements. By means of lever *H* (see Fig. 2) controlling belt shifters *J*, *J*, the belt can be changed from

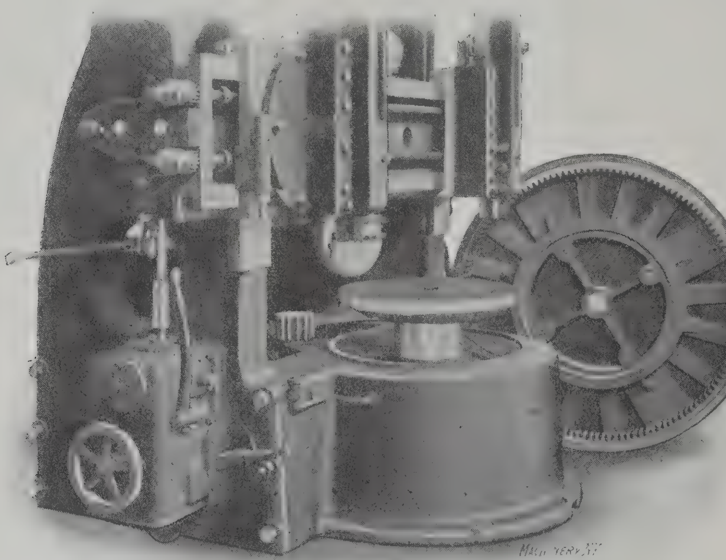


Fig. 3. Details, showing Construction of the Spindle Bearing and Internal Gear Drive used on the 60- and 72-inch Mills

one step of the cone pulley to another with great rapidity and without any injury to the belt. In actual operation the change for the entire range of speeds given by the 5 steps in the cone pulleys has been obtained in eight seconds, going from the slowest to the fastest step and back again, and stopping momentarily at each speed.

The countershaft is attached directly to the upper parts of the housings by means of brackets having ring oiled bearings. It thus becomes a part of the machine itself. It carries the upper cone pulley and tight and loose pulleys. The loose pulley is provided with bronze bushings and is made smaller than the tight pulley, so that the strain of the belt is removed when the machine is not running. The machine may be controlled from either side of the mill by means of a horizontal rod connected with the shifter, having

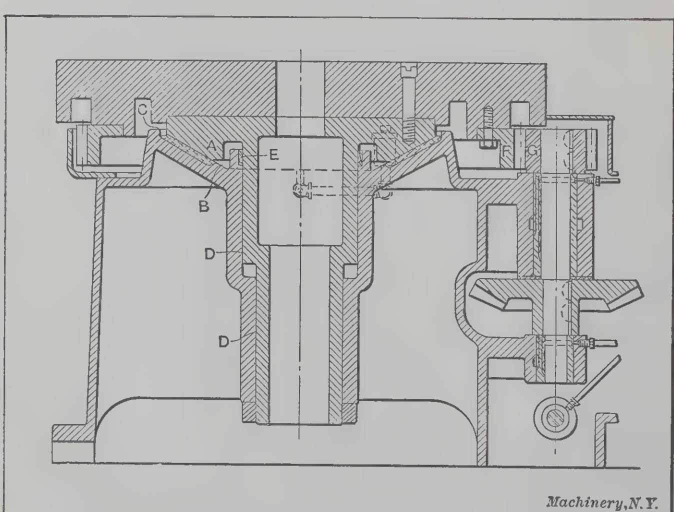


Fig. 4. Construction of the Taper Spindle Bearing and Provision for Oiling

a spade handle at each end. One of these handles is shown at *M* in Fig. 2.

The cone pulley is mounted on the driving shaft of the gear box, as shown in Fig. 2. This mechanism takes the place of the back-gearing ordinarily used. The speed change is made by gears and clutches which are constantly immersed in a bath of oil. The slow speed is thrown out and in by means of lever *Z*, conveniently located at the side of the machine. This, with the five-step cone pulley, gives 10 speeds, all in geometrical progression.

The speed box, when assembled, is oil-tight, and the proper height of oil is shown at all times by the glass gage and oil filler on the outside. All the bearings are bushed with phosphor-bronze and are provided with ring oilers for additional protection. The oil runs into the oil box from the main reservoir. By removing the single plug under the oil feed cup, the entire box can be drained dry. At any time it is necessary to make repairs the mechanism can be removed from the machine in its entirety, so that every part is accessible.

A brake is furnished which enables the operator to stop the machine with the table in any desired position. It is operated by a foot-treadle placed within easy reach on the working side of the machine. This brake, as shown at *B* in Fig. 9, is provided with taper friction surfaces, formed with hard maple shoes and wedges. It is applied to the inside of the cone pulley, as seen at *T* in Fig. 2. The conical type of friction prevents any distortion of the bearings; since it is operated directly on the prime mover, all shock and jar is eliminated and the braking effect is practically instantaneous.

The Feed Mechanism

The feeding mechanism for each head is contained in a separate case, one on each side of the mill, permitting each to work independently of the other. By turning the hand-wheel *L* one revolution, five changes of feed are obtained. The further movement of the multiplying lever, projecting from the front of the gear-box in Figs. 1 and 3, permits hand-wheel *L* to be revolved and gives five more changes, making ten in all. The vertical feed shaft *K*, extending upward to the feed case, engages the mechanism on each end of the rail, which conveys

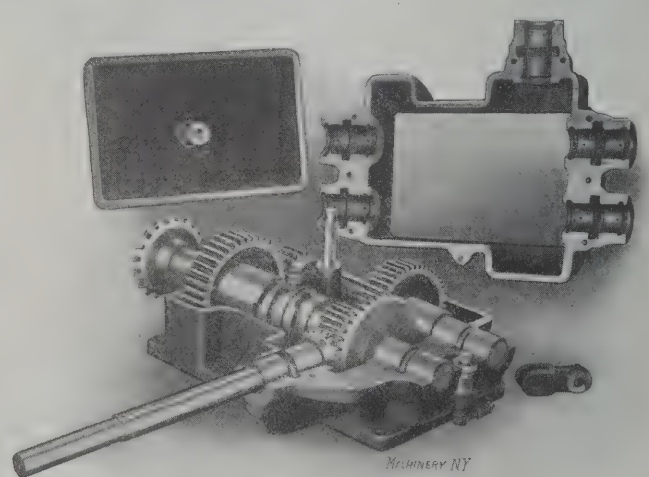


Fig. 5. Speed Box, showing Enclosed Mechanism and Ring Oiling Bearings

motion to the horizontal rods and screws in the cross-rail operating the heads horizontally, and vertically. The usual slip gears on the ends of the rods and screws are eliminated, and quick-adjusting positive clutches are substituted (see *D* in Fig. 9). This enables the operator to instantly change the feed from vertical to horizontal and *vice versa*.

Either feed can be reversed by lever *O* at each end of the rail which controls a clutch playing between a set of reversing bevel gears in box *P*. These gears are connected with the feed shafts through a safety shear pin device shown at *Q* in Fig. 2, and in detail in Fig. 6. At the left of the latter engraving it is shown in position, while at the right it is shown taken apart. The connecting shaft is made in two sections with little couplings on their ends, adjoining each other. The motion is transmitted from the driving member to the driven one by a small pin passing through each flange of the coupling. Any abnormal strain on the feeding mechanism in excess of that necessary on the heaviest cuts will

shear this pin off, and thus protect the mechanism from breakage.

When a pin shears, one-half of the coupling is turned half around until the slots are opposite the broken pins, which are then readily removed as shown at the right of Fig. 6. The couplings are then turned until the holes are in line again, when a new pin is inserted and the mill is ready to run. The whole operation of taking out the old pin and putting in a new one only takes a few seconds. There is nothing to adjust or to get out of order in the device. A supply of pins is sent out with each machine, but in case these are exhausted, new ones can be readily obtained, as they are made from the ordinary wire nails found around any shop.

Power Rapid Traverse

An important feature of this machine relates to the construction of the power rapid traverse. This is provided for all the movements of the tools, whether in a horizontal, vertical or angular direction. It is obtained from the same vertical

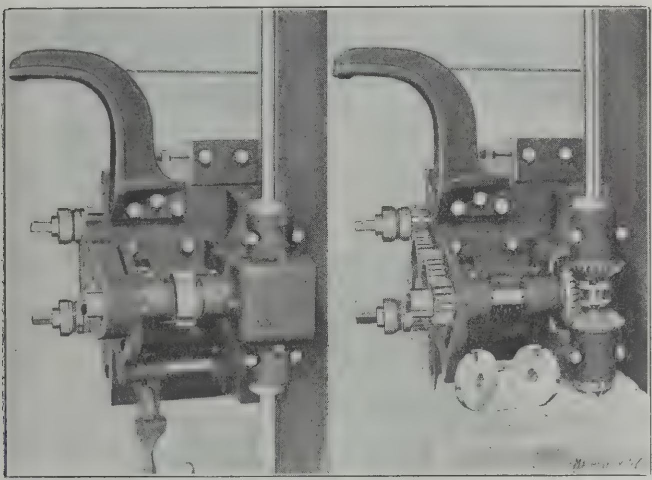


Fig. 6. The Safety Shear Pin Device for Protecting the Feed Mechanism, showing Ease of Replacing Shearing Pin

shaft K as the feed, and is controlled by the vertical lever N (see Fig. 2) at the side of the feed-box. This lever has two operating positions—either pulled in or pushed back. The regular gear feed is always engaged when the lever is in the back position, and if the feed is thrown in, the tool will then move in the direction determined by the position of the feed reverse lever O at the end of the cross-rail. On the other hand, the rapid traverse is always engaged and the gear feed is thrown out when the lever is in the forward position, and the tool will then travel rapidly in the opposite direction from that given by the gear feed.

It may take a word or two of explanation to show the advantage of this construction. It makes it impossible for

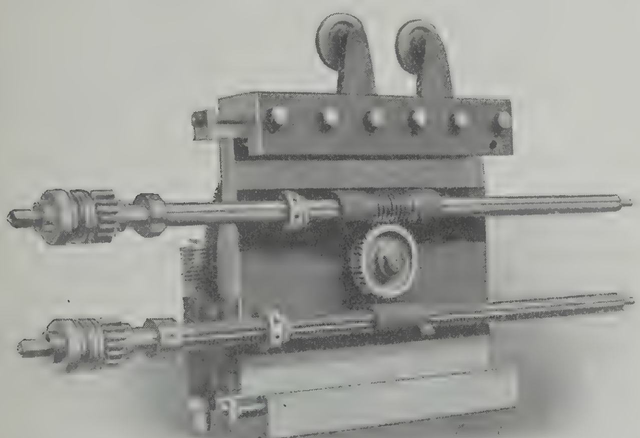


Fig. 7. Rear View of Saddle for Swivel Head, showing Large Diameter of Rods and Screws and the Fine Adjusting Collars for the Tool Movements

the operator to throw in the rapid traverse the wrong way, and thus avoids all chance of accident. For illustration, suppose the tool is feeding horizontally along the rail, taking a facing cut on a piece of work. Having reached the end of the cut, say with the tool up against the shoulder, the operator desires to disengage the feed and return the tool to the starting point again for a finishing cut. He simply pulls the rapid traverse lever forward. No mental effort is required, and he does not have to stop to think for a second which way to pull it, as there is only one direction in which it can be moved. It makes no difference whether the tool

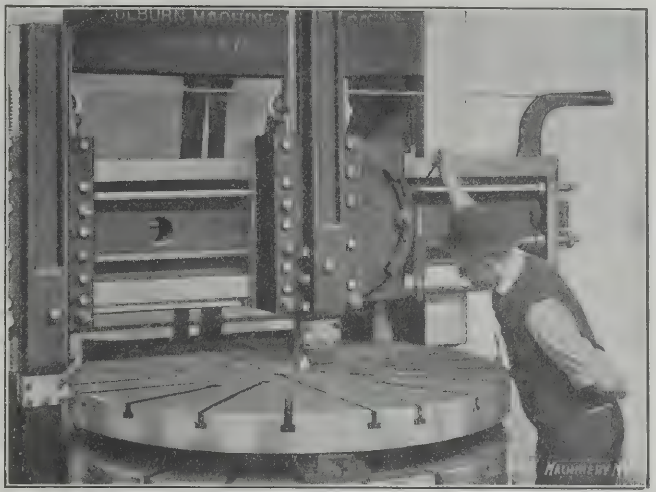


Fig. 8. Method of Making Minute Adjustments, which permits Close Observation of the Tool at the Same Time

is feeding to the right or to the left horizontally, or up and down vertically, the same lever controls the feed and rapid traverse in every case, and pulling the lever always throws the gear feed out and the rapid traverse in, at the same time reversing the direction of the travel of the tool. The rapid movement is obtained from the shaft at the top of the machine through vertical cones having cork inserts, of which one is shown at R in Fig. 2, and in detail at C in Fig. 9. This con-

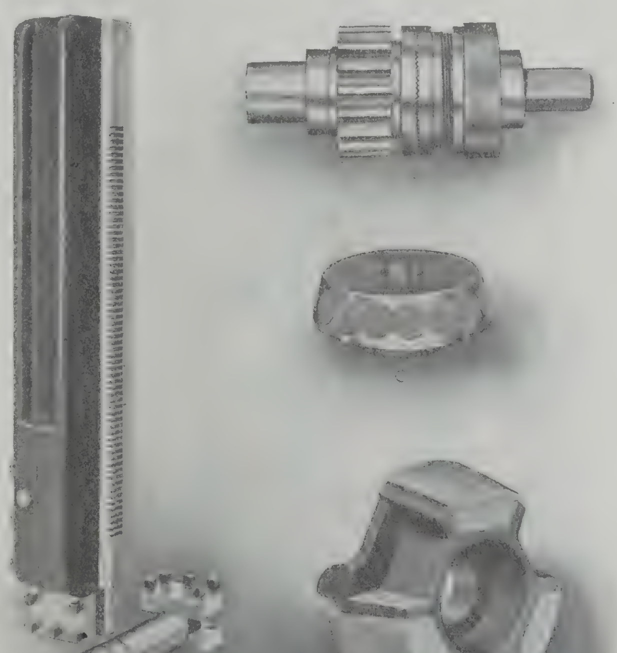


Fig. 9. Various Details. A—Ram. B—Brake Cone with Maple Shoes Treated with Paraffine. C—Cork Insert Clutch Member for Rapid Traverse. D—Quick-adjusting Clutch for Controlling Cross and Down Feeds

struction, which has proved its value in automobile design, does away with the necessity for flooded lubrication at this point.

The fine adjusting collar construction illustrated in Figs. 7 and 8, in connection with the rapid traverse just described, does away with the necessity for hand-cranking, although, of course, the ends of the shafts and screws in the cross-rail are squared so that a crank can be used in an emergency, or whenever the operator prefers. To permit the fine adjustment which the rapid traverse does not give, it has usually been necessary to go to the end of the cross-rail and use the

crank-handle. In this design, however, both the feed-screws and the rods in the cross-rail are splined and each has a capstan collar fitted thereto with keys, and free to slide on them. By turning the capstan collars with a small lever furnished for this purpose, the rods and screws are turned also.

The operator can stand close to his work, as shown in Fig. 8, and by placing the capstan collars in the most convenient position, he can make fine adjustments of the tools in any direction without having to go to the end of the rail where he could not readily observe the movement of the tool point. When the heads are moved to the extreme outer position on the cross-rail, these collars do not in any way interfere, as is apparent in Fig. 1, so that it is not necessary to make the rails any longer for the sake of having the fine adjustment.

Attachments and Extra Equipment

Another attachment not shown here, is provided for thread cutting. When this is used, the feed change wheel *L* is set to a predetermined point at which the table and vertical feed shaft revolve in unison. A single tooth clutch, connected with the rapid traverse lever *N*, is used for returning the tool quickly to its starting point; and when this is again thrown in to connect the mechanism for threading, the tool must always catch the thread. This is the familiar construction used on certain types of engine lathes in which the lead-screw and not the work is reversed for thread cutting. While the gear connection for threading is not furnished regularly it can be put on at any time. It is attached to the bracket at the end of the cross-rail, always on the right-hand head. The change gears provided allow all threads to be cut between 2 and 14 per inch. For drum scoring, special arrangements are made which allow leads as coarse as one turn in 2 inches to be cut with the same facility as for the finer pitches.

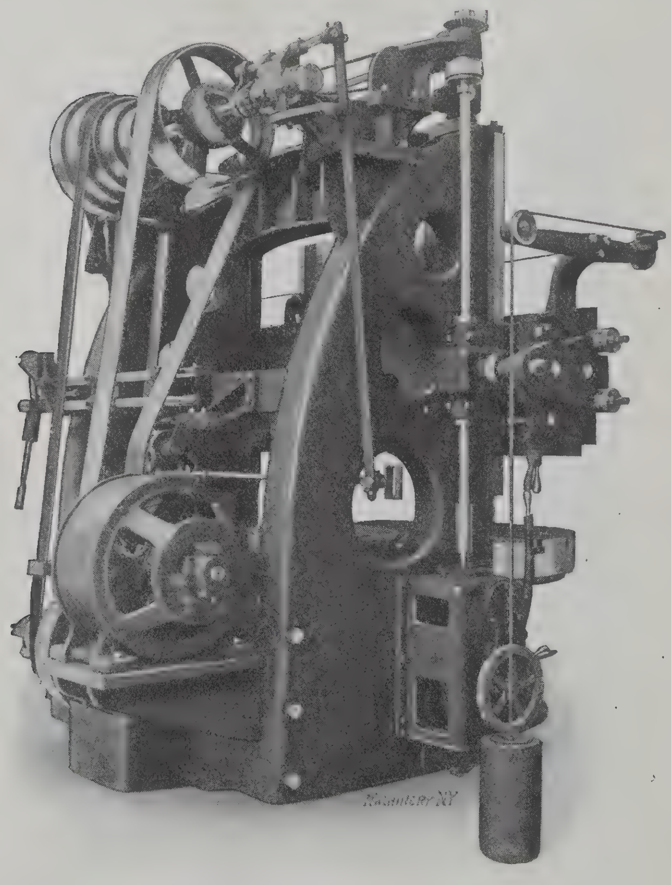


Fig. 10. Constant-speed Motor-drive for Colburn "New Model" Boring Mills

The self-contained countershaft construction described in the beginning of the article particularly adapts the machine to motor-drive. The 5-step cone, mechanical belt shifter and the speed box, furnish a wide range of speed changes so that a constant speed motor is recommended. The motor is mounted, as shown in Fig. 10, on a bracket in the rear, and is belted to a pulley on the countershaft. In order to enable the operator to stop or start the mill without stopping the motor, a clutch pulley replaces the regular tight and loose pulleys, and is operated by the same levers, with handles *M* (see Fig. 2) on both sides of the mill.

All the various features of design thus described apply to the whole line from the 42-inch to the 72-inch swing. There are some slight changes in the smaller sizes. As explained in connection with Figs. 3 and 4, for instance, an external spur gear is used for the table drive on the smaller sizes in place of an internal gear. Besides this the feed box is of different design on the 42-inch mill, as shown in Fig. 11. This change was made for the sake of securing compactness and to prevent the gear-box from extending out beyond the ends of the cross-rail where it would interfere with the movements of the operator. Turrets will be provided for the right-hand head, in the three smaller sizes if required by the purchaser. One of these is also shown in Fig. 11.

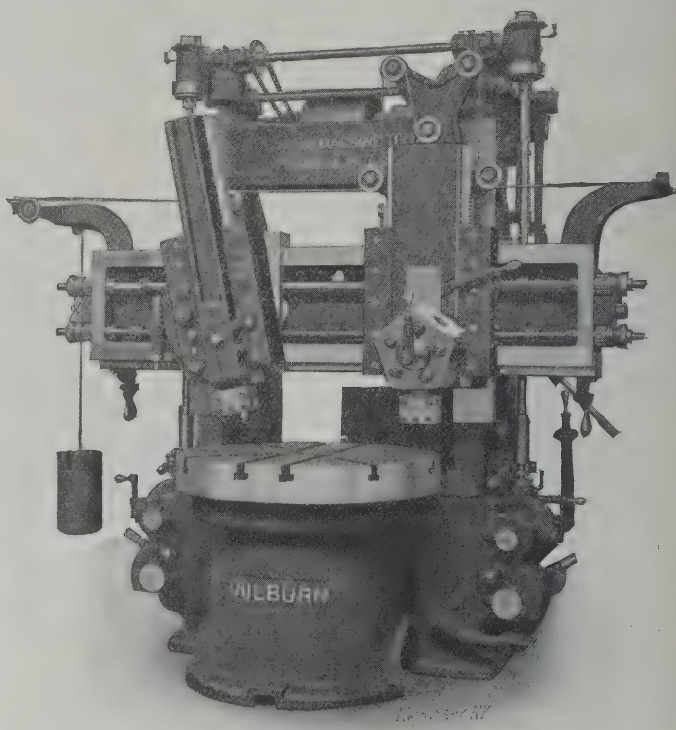


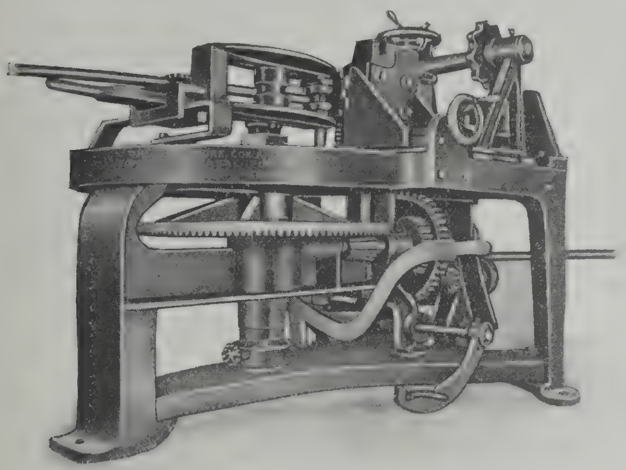
Fig. 11. The 42-inch Machine, showing Alternative Form of Feed Box and Turret on the Right-hand Head

COX PIPE AND TUBE BENDING MACHINES

A series of pipe and tube bending machines is being brought out by J. Fillmore Cox & Co., Bayonne, N. J. These machines, of which one known as "Gem—Type B-No. 2" pipe and tube bending machine is shown in the illustration, embodying several interesting features, of which the most important is that the machine is capable of bending pipe and tubing cold, without the use of an inner filling, to any desired shape without injury to the metal in the pipe. Machines are being built that will take sizes from 1/8-inch tube up to the largest size which is likely to be required to be bent. The machine is, in many respects, a radical departure from previous designs of pipe bending machines, and in view of the rather crude and expensive methods and devices used in many places for bending pipe, it will undoubtedly prove of value to manufacturers who have a great deal of pipe bending to do. When bending pipes, a special collapsible plug is used in connection with a patented flexible chain operating the mandrel. The pipe is bent around rollers with specially shaped grooves, and levers are provided for certain operations with graduated adjustment for setting the bending rollers, so that certain predetermined bends will be produced.

The machine is gear-driven, and a "twin pinion" system of gearing has been incorporated which prevents any possible chance of backlash or lost motion, so that at all times a steady power is obtained, which is not generally possible with

other methods. An automatic stop arrangement is provided by means of which it is possible to obtain exact duplications of bends. A safety stop is also provided for the power mechanism. The main vertical shaft has been made of heavy dimensions so as to be able to easily withstand the heavy stresses to which it is subjected when in operation. In cases where a great number of pipes are to be bent in the same way, they may be cut to the same length and placed in a magazine attachment from which they are fed gradually to the working mechanism. Radial bends, for instance, may be automatically made when the magazine attachment is provided. Such bends as a conical helix and regular helical coils may be performed on this machine by the use of special attachments. Outside of its application to the bending of pipes, the machine may also be used for other kinds of bending, such as the bending of steel rails, angle irons and other structural shapes.



Pipe Bending Machine, built by J. Fillmore Cox & Co., Bayonne, N. J.

ROCKFORD MULTIPLE SPINDLE DRILLS

We have previously described the sensitive drills both of the floor and bench types made by the Rockford Lathe & Drill Co., of Rockford, Ill. Both of these machines can now be furnished in the multiple spindle type as shown herewith. All the advantages of the single spindle machines are retained and a number of new features of design are added.

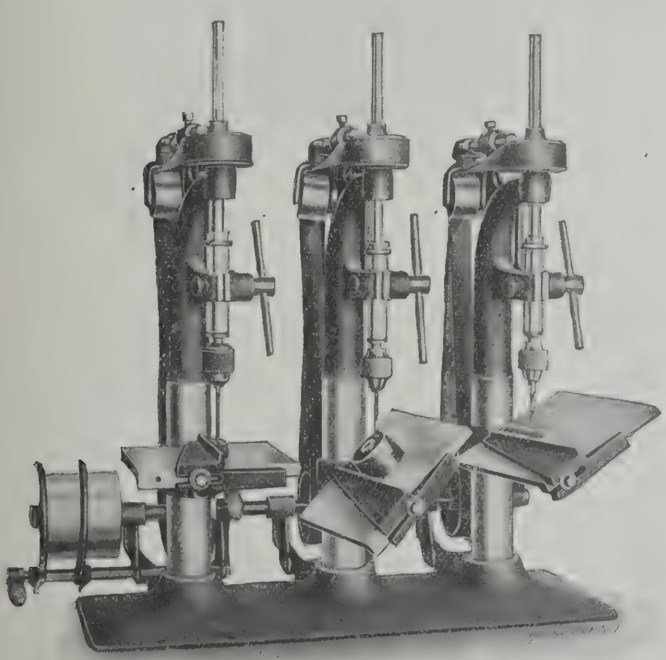


Fig. 1. Rockford Three-spindle Bench Drill, showing Use of Tilting Table and Adjustable Gage

Fig. 2 shows the floor type of multiple spindle drill. The single spindle machine was first illustrated and described in the June, 1908, number of MACHINERY, under the old firm name of "Rockford Machine & Shuttle Co. As may be seen, the tool is provided with a substantial base and column, carrying, in the case shown, four spindle heads. It will be furnished as a two- or three-spindle machine when desired. Among the points that should be noticed is the self-contained countershaft with tight and loose pulley and convenient belt shifter. The work-table is adjustable for height, being counterbalanced inside the column. Another important improvement consists in mounting this table on a three-point adjustable bearing, making it possible to keep its surface in alignment with the spindle under all conditions. The two outer supports are adjustable by the threaded studs and nuts shown. Belt guards are provided for the spindle-driving pulley. The stop collars for the depth of the drilling are mounted on the upper ends of the spindle as shown.

The bench machine shown in Fig. 1 was illustrated as a single spindle machine in the New Tools department of the November, 1909, issue of MACHINERY. In this case, also, a self-contained countershaft with a convenient belt-shifter is provided. A two-step cone for each spindle is mounted on the countershaft from which the belt is led over the tightener pulleys to the spindle driving pulley above, permitting the separate spindles to be given speeds appropriate to the diameter of hole drilled. The machine will work to the center of a 10-inch circle. The stop for depth is located in this case on the spindle sleeve.

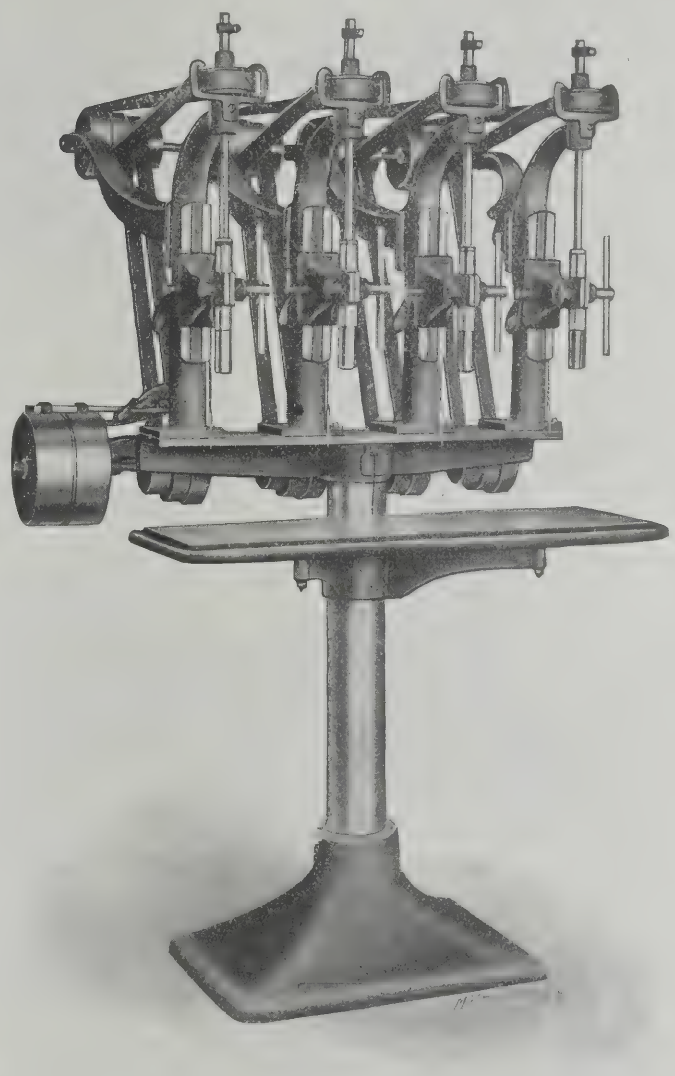


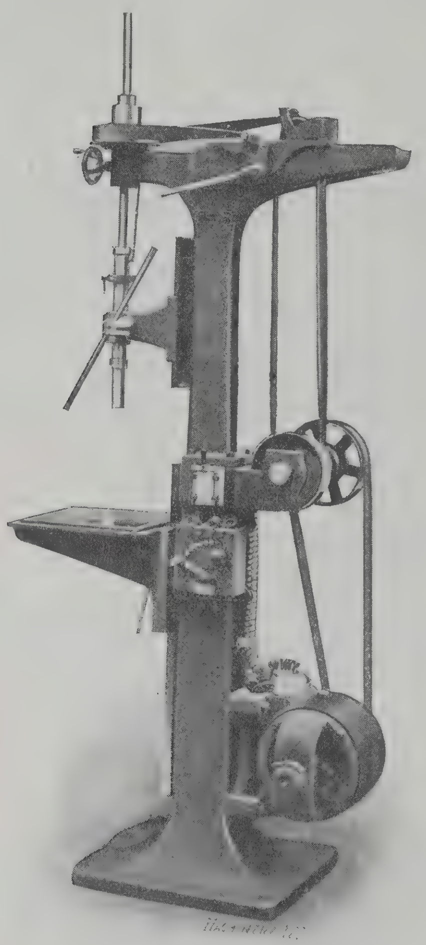
Fig. 2. Four-spindle Floor Type of Drill

Fig. 1 illustrates very plainly the usefulness of one of the special features of this make of drills. The work-table can be swung around the column to any point desired, or can be turned, as shown in the case of the central and right-hand heads, to any desired angle about a horizontal axis. The usefulness of this adjustment is increased by the provision of a squared block or gage, which may be adjustably clamped to the table as shown. Reading from the left, in the first case

this is being used simply to locate a block so that the hole will be drilled at the desired distance from the edge. In the second case this gage is used to support a pulley while an oil or set-screw hole is drilled at an angle, the table being tilted for this purpose. In the third case the gage, in conjunction with the surface of the table, provides a V-block for drilling holes into round work. The use of this device makes it unnecessary to rig up temporary holding contrivances out of blocking, bolts, clamps, etc., and greatly increases the range of the machine.

MOTOR-DRIVEN AVEY SENSITIVE DRILL PRESS

A sensitive drill press made by the Cincinnati Pulley Machinery Co., Cincinnati, Ohio, was illustrated and described in the February, 1909, issue of MACHINERY. The machine then illustrated was provided with loose and fast pulleys and was intended to be driven from a countershaft. In the accompanying engraving the same machine is shown provided with individual motor drive, the motor being mounted on a bracket on the lower part of the column and driving the intermediate cone pulley shaft by means of belting. The starting box is placed on the side of the column, as shown. This arrangement is very simple and compact, and makes it possible to apply motor drives to these drill presses when required without making any change in the general design of the machine. The bracket on which the motor is mounted has vertical adjustment on the column so that proper belt tension can be secured at all times. The motor shown in the illustration is a General Electric ½-horse-power motor.

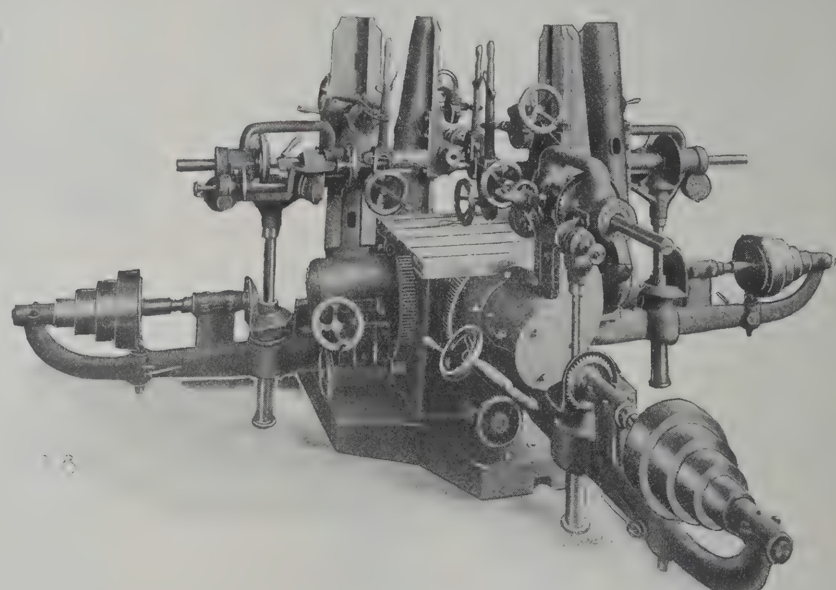


Avey Motor-driven Sensitive Drill Press, built by the Cincinnati Pulley Machinery Co.

It will be recalled from the previous description of this machine that the particular feature of it is the driving arrangement. Of additional features may be mentioned that it runs on ball bearings throughout, and has a graduated spindle sleeve with a stop collet having a clamp screw which requires no wrench or screw-driver; the graduated spindle sleeve makes scale measurements for depth of holes unnecessary. The spindle has a motion of 13½ inches, and a rack feed of 6 inches. The maximum distance of the spindle from the table is 35½ inches. While the drill is shown in the illustration as a single spindle machine, it may be provided with two, three and four spindles on the same base column, if required. The machine has a capacity for using drills provided with a No. 2 Morse taper, the largest diameter of drills with this taper being 29/32 inch.

BARNES HORIZONTAL RADIAL DRILL WITH FOUR HEADS

A horizontal radial drill built by the W. F. & John Barnes Co., 231 Ruby Street, Rockford, Ill., was illustrated and described in the December, 1908, issue of MACHINERY. This type of drilling machine has been found especially valuable for boring jigs, as the horizontal table is much better adapted for holding large irregular castings than is the vertical angle plate. The accompanying illustration shows a special machine of this type recently brought out by the company. This machine is provided with four heads, as shown, one on each side of the table. Each of the heads is of the same design and construction as the head used with the regular No. 3 horizontal radial drill, the special part being the table which has a top 30 inches square. The machine was built especially for boring, tapping, and other operations on a casting containing two different sized holes on each of its four sides. By having four heads working at once, the casting can be strapped to the table and left in this position while the heads which are adjustable both vertically and radially can be set so that the spindles come into proper positions to perform the operations required on the casting. It is readily seen that a large range of work can in this way be taken care of by machines designed with two or more heads mounted on the same table. The manufacturers often furnish the heads only, the customers making their own base or table to suit various requirements. The total weight of the machine shown in the accompanying illustration is 9,000 pounds.



Horizontal Radial Drill, made by the W. F. & John Barnes Co, Rockford, Ill.

As will be recalled from the previous description of the regular machine, the spindle is capable of all the movements and adjustments of a regular radial drill, but it has its spindle horizontal instead of vertical. The only adjustment which is not provided is that corresponding to the raising and lowering of the radial arm which, however, is not required, owing to the fact that the horizontal table allows the work to be clamped in any position relative to the spindle so that in this way the vertical adjustment of the arm in the ordinary radial drill is taken care of. The maximum distance from the table to the centers of the spindles is 29½ inches, the minimum being 2⅜ inches. The spindle which is provided with a No. 5 Morse taper hole has a horizontal travel of 18 inches. The drilling capacity is up to 3-inch holes in cast iron and 2-inch holes in steel, with a tapping capacity of 3-inch regular, and 2½-inch pipe taps.

The increasing tendency to use special machinery for operations which can be more rapidly handled in machines especially adapted for the purpose, will doubtless make machines of this type popular with manufacturers of interchangeable machine parts.

TOLEDO PRESSES OF UNUSUAL SIZES

The accompanying illustrations, Figs. 1 and 2, show two powerful presses of unusual dimensions recently designed and built by the Toledo Machine & Tool Co., Toledo, Ohio. These presses are constructed for cutting and forming the steel bodies and frames for automobiles. The press in Fig. 1 is intended for pressing up or forming the side and cross channels for the lower or under frame. This work has formerly been done on hydraulic presses, but the best results obtainable may be produced by the use of the press illustrated.

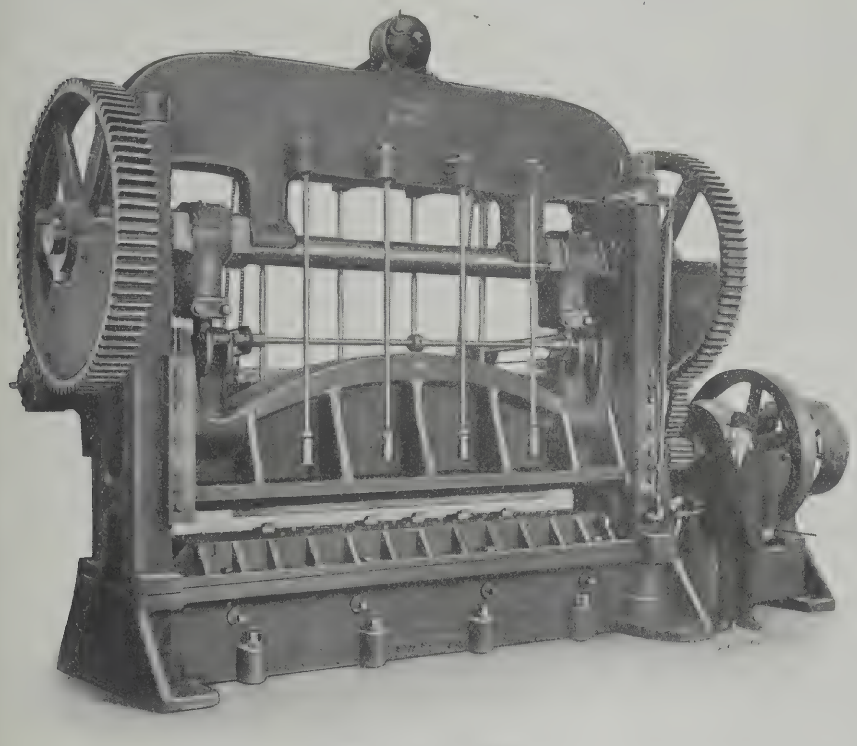


Fig. 1. Large Press for Automobile Frame Work, built by the Toledo Machine & Tool Co., Toledo, O.

In the illustration, the dies are shown in position for performing the work. The lower die is fitted with a pressure attachment, having a capacity for exerting a pressure of about 500 tons. This prevents the distortion of the strip while being formed. The press itself has a capacity or ram pressure of nearly 900 tons. It operates at the rate of eight strokes per minute.

As shown in the illustration, the press is fitted with twin gears on the crankshaft. Engaging with these gears are two pinions on the heavy pinion shaft driven through gearing from the main driving shaft. A powerful friction clutch with hand lever control is provided between the driving pulleys and the gearing, giving the operator complete control of the press stroke at all points. An interesting feature in connection with the press is the motor-driven elevating attachment for adjusting the slide, this being required on account of the size and weight of the sliding parts. This attachment is operated by a four horse-power motor mounted on the top of the frame arch, as shown in the engraving. The power is transmitted down to a rear shaft, by means of sprockets and link belts, and from there is carried over to the worm shafts, on which are mounted worms engaging with worm-wheels on each of the right- and left-hand pitman screws. This arrangement is plainly shown in the engraving. A reversible friction clutch is provided for this attachment, just below the motor, and is attached to the rear of the arch. As the illustration shows a front view of the machine, this clutch is, therefore, not in view. The lever and segment by means of which it is controlled, however, is shown to the right in the illustration, directly beneath the man's hand.

Some of the more important dimensions and weight of the machine are as follows: The stroke or slide motion is 8 inches; the ratio of the gearing is 40 to 1; the size of the main gears is 86 inches diameter by 10 inches face. The width between the housings is 14 feet 4 inches, and the height from the floor line to the top, 15 feet, the bed extending 2 feet below the floor line. The floor space required over all is 9 feet 4 inches by 25 feet 10 inches. The power required for operating the press is 40 horse-power, and the total weight of the press as illustrated is 185,000 pounds.

In Fig. 2 is shown a machine designed for pressing the parts for automobile bodies, including the seats and panels for touring car bodies. An unusual distance from the bed to the slide is consequently provided, in order to accommodate the dies necessary for pressing up large steel backs and seats. A stroke of 24 inches is necessary for this purpose. An additional sub-base or bed is attached to the top of the main bed of the machine. This sub-base is not shown in the illustration. It is 40 inches high, and when in position reduces the height or distance between the bed and the slide to what would ordinarily be required for regular work. The bed-plate or bolster which is used on the main bed of the press will fit on the sub-base also. The same applies to the drawing attachment which is used in connection with the bed for operating the drawing and forming dies necessary for this class of work. These attachments are made removable and may be changed from one bed to the other, in a reasonably short length of time. The machine is provided with clutch arrangement and gearing similar to the press previously described.

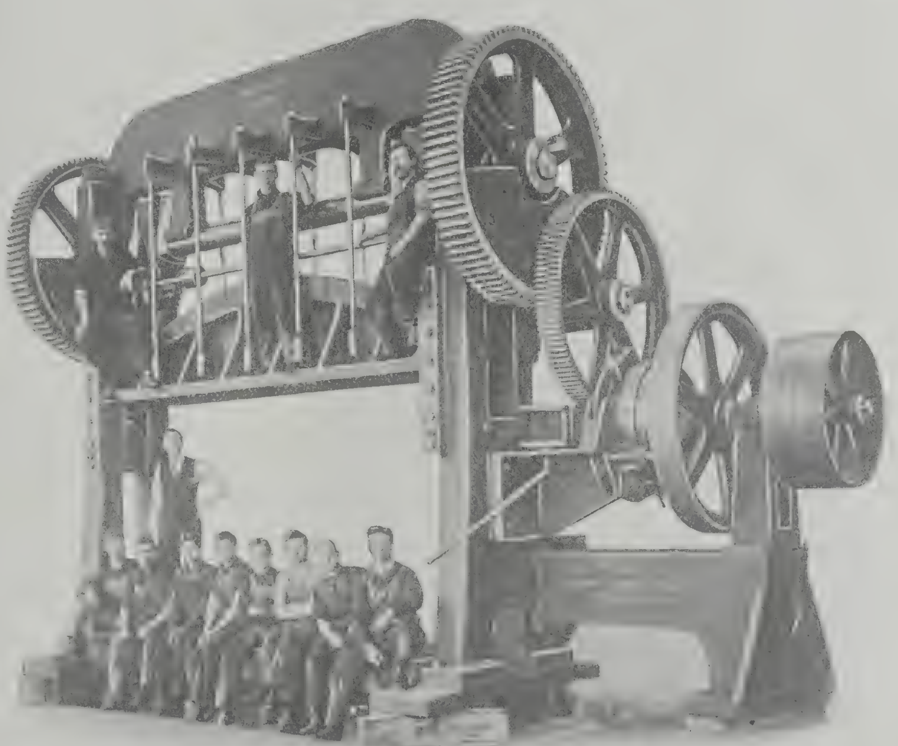


Fig. 2. Toledo Press for Automobile Body Parts

The main dimensions and weight of the press are as follows: The ratio of the gearing is 45 to 1, the number strokes per minute being 6. The width between the housings

is 12 feet 4 inches and the total height above the floor line is 16 feet. The bed extends 40 inches below the floor line. The floor space required is 8 feet 4 inches by 23 feet 4 inches. The total weight of the press is 165,000 pounds.

ROWBOTTOM CAM CUTTING MACHINE

The Rowbottom Machine Co., of Waterville, Conn., is building the cam cutting machine shown herewith. Among other interesting features this machine has the advantage of being universal—that is to say, it will cut plate and face cams, or barrel cams, without requiring the use of attachments or separate heads. It is also provided with unusually convenient adjustments which increase its adaptability for difficult work, as will be explained.

The machine comprises, primarily, a rigid bed on which are mounted a head for the master cam *H*, a swiveling work-

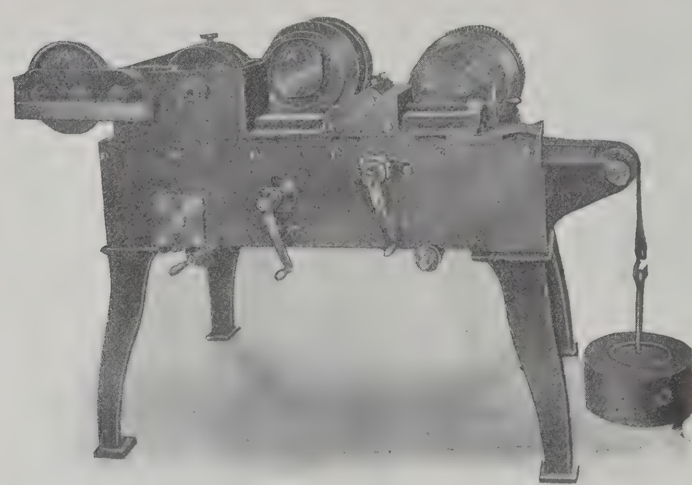


Fig. 1. The Rowbottom Universal Cam Cutting Machine

head *F* for the cam *K* being cut, and a slide on which is mounted the cutter spindle and its driving mechanism and the adjustable bracket *J* for the master cam roll. The master cam spindle and the work-spindle are fixed in place in the bed and revolve together with the feed mechanism. The master cam roll and the cutter spindle, being mounted on the same slide, receive motion from the master cam, which thus gives an appropriate form to the cut taken in the work. The weight *D* connected to the slide holds the follower roll against the master cam.

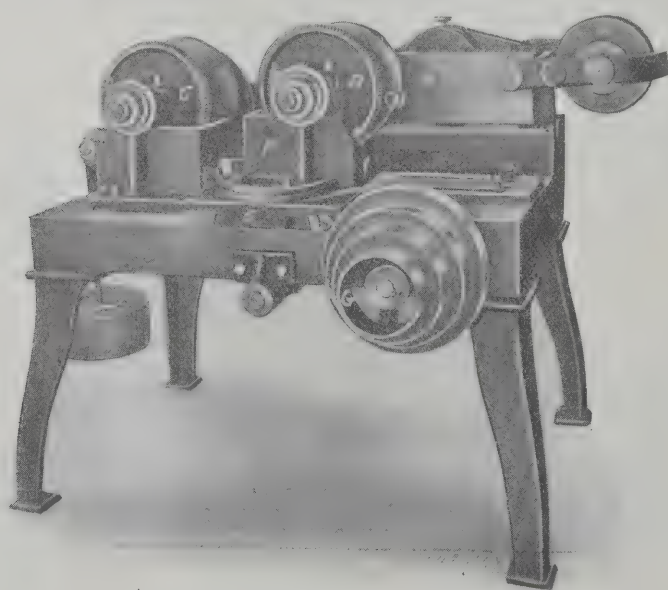


Fig. 2. Driving Side of Machine, showing Adjustment of Follow Roll Bracket on Cutter Slide

The spindle is driven by pulley *A*, which is mounted on a pivoted yoke. The pulley and the gearing contained in this yoke are heavy enough so as to keep the driving belt tightened to the proper degree throughout the movement of the slide, under the influence of the master cam. The gear-box, which is shown with cover removed, provides two changes of speed. This with the two on the double driving pulley *A*, gives four in all. All the gearing in the gear-box runs in an oil bath.

The rotation of the master cam and work-spindles is effected through cone pulley *G*, which is connected by gearing with

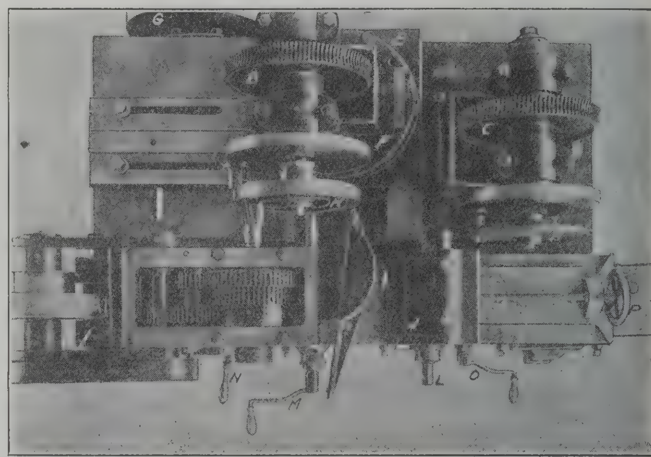


Fig. 3. Machine set up for Cutting Face and Plate Cams

worms meshing with worm-wheels *B* and *C*. Lever *N* controls this automatic feed, throwing it in or out. When it is thrown out, it may be operated by hand by placing the crank on feed shaft *O*. The handle on *M* operates the cross-slide screw by means of which the work-slide *E*, carrying the swivel work-head *F*, is fed in toward the cutter to give the required depth of cut. This adjustment is provided with a micrometer dial. By placing a crank on shaft *L* the slide carrying the former roll and the cutter spindle can be rapidly

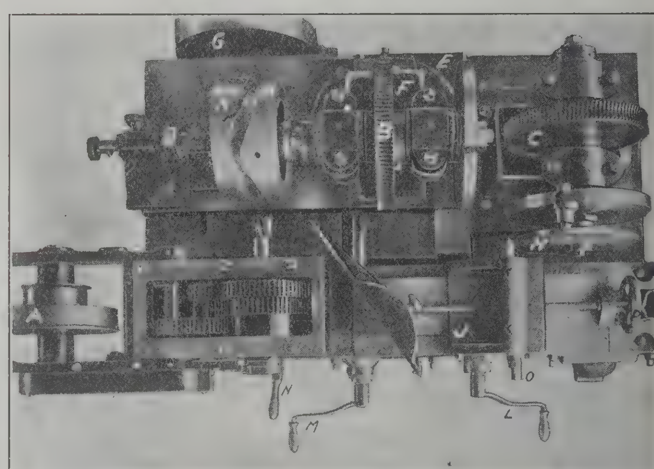


Fig. 4. Machine set up for Cutting Barrel Cams

drawn back against the tension of weight *D* for the purpose of inspection, removal of work, etc.; this movement is effected by a pinion on the shaft engaging the rack on the under side of the cutter slide. The ratchet shown on shaft *L* serves to support the slide in this position against the pressure of the weight. This ratchet has, of course, to be raised to allow the former roll to come back to its bearing on the cam. When ready to start, the pawl is thrown back from the ratchet, allowing the weight to be brought back into contact with the former roll and the periphery of the cam.

The particular construction of the machine, as described, offers certain advantages which are best seen from an inspection of Figs. 3 and 4. The master cam is always of the plate variety. This means that it is made in the least expensive way and in the way which permits the greatest accuracy. It is only the work-head *F* which is altered to permit the cutting of plate, face and barrel cams as may be required. This change from face to barrel cams, as has been explained, is done without the use of attachments of any kind, it being only necessary to swivel the head around at right angles. It is shown in the two positions in Figs. 3 and 4. This construction also fits the machine for cams cut on conical surfaces—a construction met with once in a great while. For

this work the head is simply swiveled to the angle required by the cone on which the cam is to be cut.

Another exceedingly useful adjustment is that of the former roll bracket *J* along the cutter-slide. This is controlled by a screw operated by handwheel *P*. It serves two purposes: For one thing, it may be used in connection with the quick traverse shaft *L* to adjust the forming roll and cutter to such a distance apart that the latter will center with a roughly cast groove in a barrel cam. By rapidly turning shaft *O* by hand, it can be found whether or not the cutter is centered with the rough cast groove, and if any adjustment is required, this is easily effected by handwheel *P*. Another advantage of this adjustment is that it permits the cutting of cams of very steep pitch. The master-plate made for the contour is cut on a much larger diameter than that desired for the finished work. This larger diameter will give easier rises, permitting the cutter-slide to be moved back against the weight with a smoothness and precision impossible where the pitch is too steep. Graduations are provided for the movement of bracket *J* on the slide, which show how much wider the distance between the cutter-slide and the roll is than the distance between the two spindles as set up in Fig. 3. When the master cam is made to a radius larger by a given amount than that desired for the finished cam, the setting of bracket *J* to this dimension on the cutter-slide brings the work to the desired diameter.

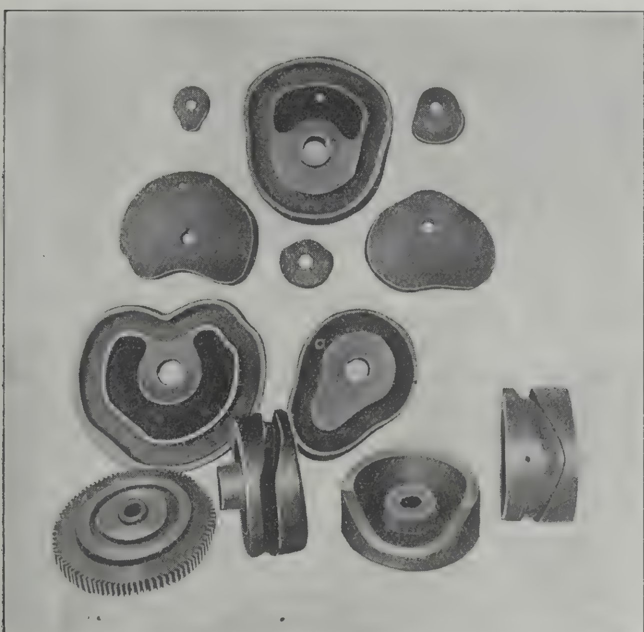


Fig. 5. Cams Cut on the Rowbottom Machine

The machine, as may be seen, is very rigidly constructed. For large work, slide *E* may be locked to the base after each feeding in to depth, so that heavy cuts can be taken. It will be seen that the machine is universal in its adaptability within the limits of size for which it is designed. In Fig. 5 is shown a variety of examples of its work.

IMPROVEMENTS IN CINCINNATI LATHE

The Cincinnati 16-inch engine lathe, built by the Cincinnati Lathe & Tool Co., Cincinnati, O., was illustrated and described in the September, 1908, issue of MACHINERY. Several improvements have now been introduced on this type of lathe, including a double-walled apron, as illustrated in Figs. 1 and 2, and a new arrangement of carriage and taper attachment, illustrated in Fig. 3.

The apron is of the box type, which gives a double and an especially rigid support to all shafts and studs mounted in it, and provides for accuracy as well as long life of all the working parts in the apron. The gears are of ten diametral pitch, thus having ample strength. The motion to the rack pinion is transmitted by compound gearing, as indicated in Fig. 2. The longitudinal and the cross friction feeds can be started, stopped or reversed while the lathe is running, but they cannot be engaged when cutting screws; this latter provision is an important safeguard when the machine is in the hands of inexperienced operators. The handwheel is provided with a thread chasing dial which permits the half-nuts to be opened, the carriage to be run back by hand, and the thread to be caught or picked up at any point. An automatic stop is also provided for throwing out the feeds.

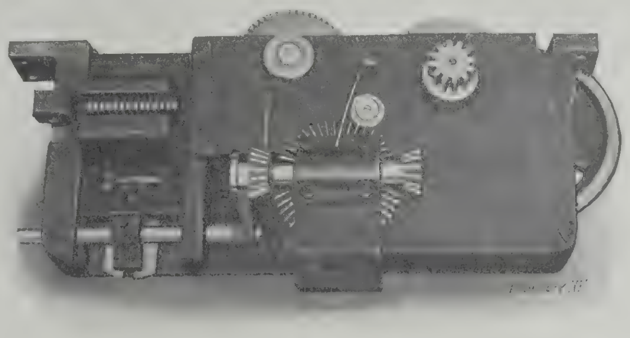


Fig. 1. Rear View of Apron of Cincinnati Lathe & Tool Co.'s 16-inch Engine Lathe

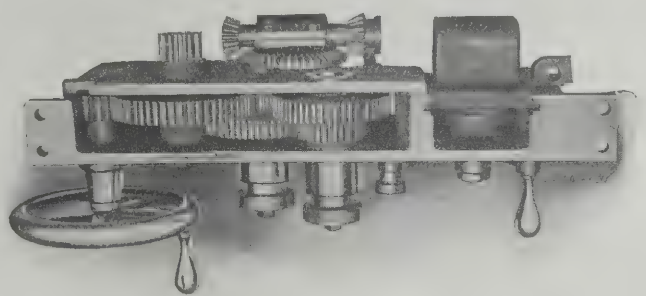


Fig. 2. View from the Top of the Apron of Lathe, showing Arrangement of Gearing

The taper attachment shown in Fig. 3 is provided with graduations at both ends, and can be firmly clamped in any position desired within its range by two heavy clamping bolts, one at each end. The carriage is gibbed both in the front and at the back and bears for its entire length of 22 inches on the V's of the bed. Both plain and compound rests are provided. Due to the heavy construction of the machine in general, as well as to the correct proportioning of the carriage details, very accurate work can be carried out on the machine. As an example, it may be mentioned that it is possible to bore holes on these lathes within 0.00025-inch in 8 inches of feed. As regards the cutting capacity of the lathe, it may

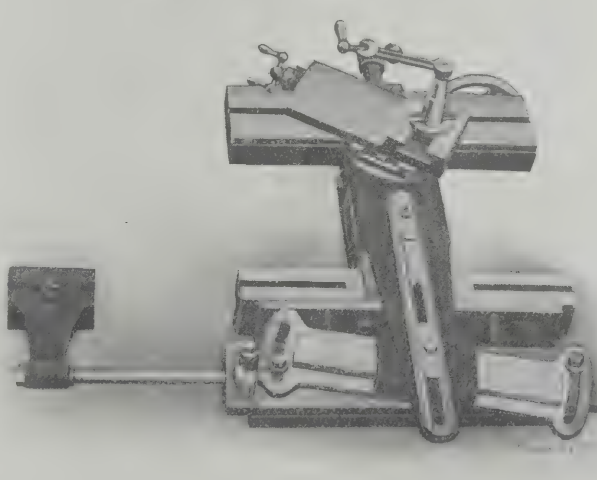


Fig. 3. Carriage Swivel Rest and Taper Attachment

be mentioned that it is used regularly in the shops of the makers for reducing 50-point carbon steel shafts as much as ⅞ inch in diameter with a feed of 1/32 inch per revolution, at a cutting speed of 60 feet per minute.

It will be recalled from the previous description of this machine that it is furnished with a quick change gear-box either for screw-cutting or for feed changes. It may also be furnished either with a 3-step cone pulley and double

back-gears or with a 5-step cone pulley and single back-gears. With a two-speed countershaft this provides for eighteen or twenty changes of speed, covering a carefully selected range.

FIFIELD HEAVY ENGINE LATHE

The accompanying illustrations show an example of a new line of heavy engine lathes made by George W. Fifield, of Lowell, Mass. The lathes of this design range from 40 to 96 inches swing over the ways. They are of modern construction and are intended for heavy and accurate work and rapid production.

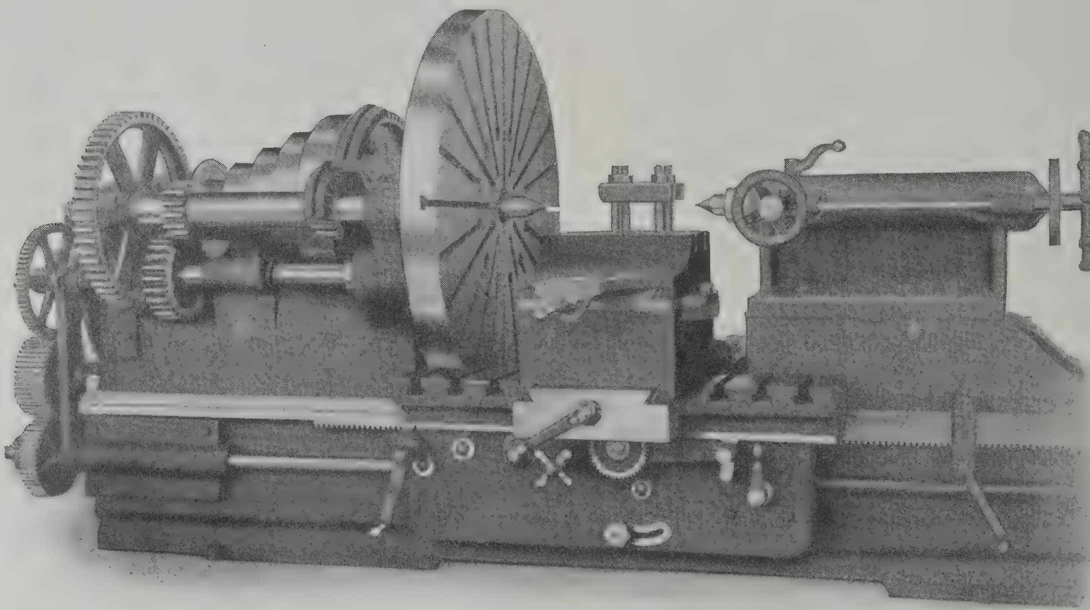


Fig. 1. An Example of a New Line of Heavy Engine Lathes

The illustrations show the general features of the design very plainly. The headstock is of the triple geared type with the "back-gearing" mounted on the front to facilitate operation. Power may be applied either directly from the cone pulley to the shaft, through back-gears in the usual manner, or through the lower or "triple gear" shaft, which carries a pinion meshing with the internal gear on the back of the faceplate. To connect with this faceplate drive, the lower shaft is thrown to the right by turning with a wrench the square-headed stud shown projecting from the left-hand bearing. This stud has pinion teeth cut in it meshing with grooves in the shaft which act as rack teeth. When the shaft is moved toward the right, the pinion on its outer end is thrown into mesh with the internal gear teeth, and the gear at the other end is moved into mesh with the middle pinion on the back-gear quill. When so set, the right hand pinion on the back-gear quill must, of course, be moved out of engagement with the spindle gear.

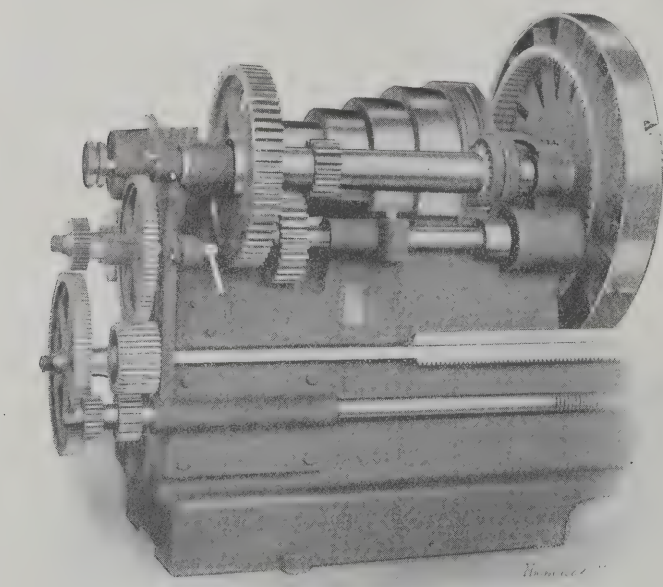


Fig. 2. Driving and Feed Gearing of Fifield Lathe

The connections at the end of the headstock provide for three changes of feed without a change of gearing. On the gear stud beneath the spindle in back of the first of the regular threading change gears, is mounted a cone of three gears. On a sector swinging about the splined lead-screw is mounted a large spur gear, adjustable to three positions longitudinally to correspond with the positions of the three members of the cone gears on the stud; a wide-face idler gear between it and the pinion on the lead-screw makes provision for this change of position. The sector is, of course, thrown in or out and clamped into position to agree with the diameter of the gear which is engaged at the time. The connections for thread cutting are made in the usual way.

The feed is reversed in the carriage. The top of the carriage is provided with a series of T-slots to hold special rests, and to clamp work for boring-bar and similar occasional operations. The tool-rest is of the four-stud type, this being most suitable for heavy work. A compound rest is furnished, and the power feed may be applied to both the cross-slide and the compound rest movements.

The 40-inch lathe is driven by a 4½-inch belt on a 5-step cone pulley whose largest diameter is 20 inches. The back-gearing is in the ratio of 1 to 13, while the triple gearing is in the ratio of 1 to 42. The weight is about 12,000 pounds. For the 96-inch swing lathe, the largest of the line, a 6-inch belt is used, running onto a 6-step cone pulley, whose largest diameter is 40 inches. The gearing ratios are, respectively, 1 to 32 and 1 to 250. This tool weighs approximately 70,000 pounds. All lathes are furnished with large faceplates, center-rests, change gears, wrenches and friction countershaft.

BAIRD WIRE-FORMING AND STAMPING MACHINE

The Baird Machine Co., of Oakville, Conn., makes the wire forming and stamping machine herewith illustrated. While this was intended originally for work such as shown in Fig. 2 (suspender loops, buckles and similar parts), the builders have found a wide range of use for it in general work. It is applicable wherever wire parts have to be bent and flattened out or stamped. The machine is essentially a combination of the standard wire-forming machine and a small punch press, the latter part of the mechanism being shown at the left-hand side of the bed.

The machine automatically takes wire from the coil, straightens, feeds and cuts it off, and then forms and stamps it. Work of the character described is made, complete, and dropped into a suitable receptacle at the rate of from 60 to

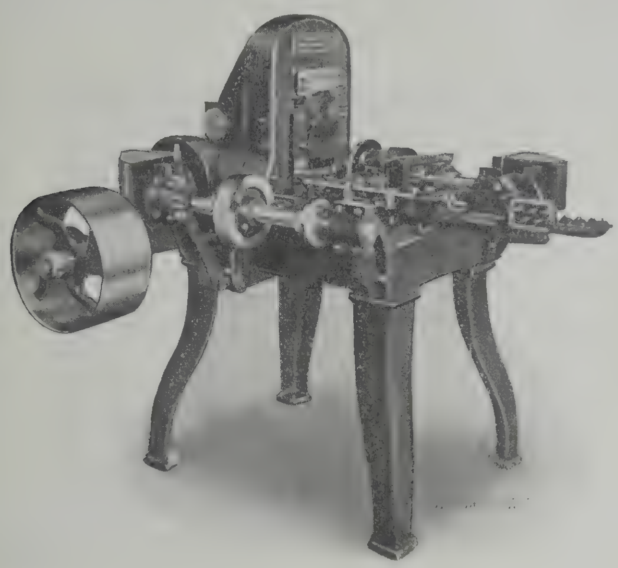


Fig. 1. An Automatic Machine for Bending and Stamping Work made from Wire

80 per minute according to the size and shape. No further attention is required than that of removing the finished work and keeping a supply of wire on hand.

High-grade materials and workmanship are used in the construction. All the bearing surfaces, such as cam linings, pins, etc., are of hardened tool steel. The sliding surfaces are

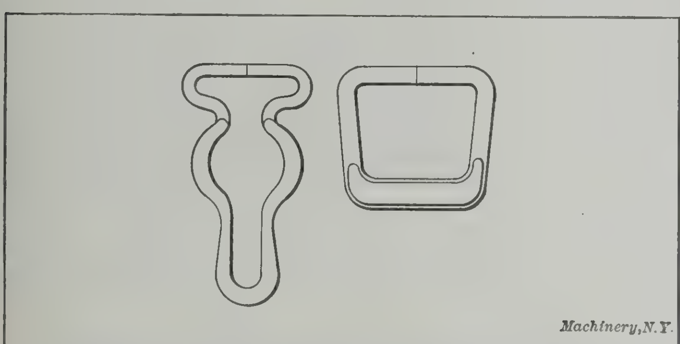


Fig. 2. Examples of Work Done on Machine shown in Fig. 1

hand-scraped to a bearing. The machine is regularly built in two sizes, the smaller of which is designed for articles which do not require more than 6 inches of wire with a maximum diameter of 0.125 inch. The larger size will make use of wire up to 9 inches long and 0.200 inch diameter.

LEIMAN ROTARY BLOWER AND VACUUM PUMP

A new design of rotary blower which is also intended to be used as a vacuum pump, has been brought out by Leiman Brothers, 62 John Street, New York. A diagrammatical view of the design of the device is shown in the line engraving, Fig. 1. In Fig. 2 the blower is shown driven by an electric motor and used as a vacuum pump; it has exhausted the air from a No. 20 gage galvanized iron tank, braced on the inside, which has collapsed on account of the vacuum produced.

As will be seen from Fig. 1, the design of the machine is very simple; the working parts consist only of a central drum or piston, and four wings attached to it by means of hinges. As soon as the machine is in motion, the outer end of these wings will come into contact with the cylinder walls, due in the first place to centrifugal action; but when the machine is in operation, the air that becomes compressed between the wings also tends to keep them in close contact with the cylinder walls, thus preventing leakage. This is one of the principal advantages of the machine, as there is no packing required, and the wings automatically, so to speak, take up their own wear. When each wing reaches the top where the air is exhausted it is kept close to the inner cylinder wall, so as to insure but a small amount of clearance, as an excessive amount of space here would impair the efficiency of the pump. At the top, the wing still presses against the cylinder wall, the bearing point gradually shifting toward the wing center. Obviously, when considerable wear has taken place on the wings as well as on the cylinder surface, the wings will still conform to the shape of the cylinder, and the efficiency of the device, even when worn, is practically unimpaired. The absence of springs and delicate parts which may break or get out of order, and also of special tips on the ends of the wings which would require frequent renewal, reduces the cost of maintenance to a great extent.

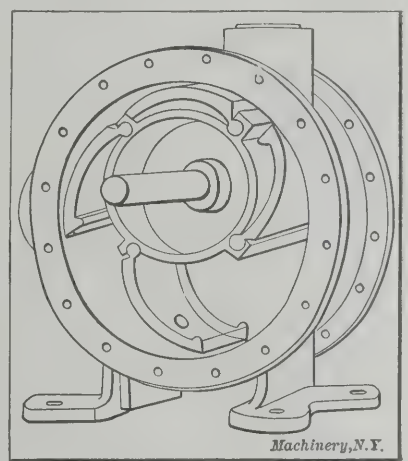


Fig. 1. Diagrammatical View, showing Design of Leiman Blower and Vacuum Pump

The main shaft bearings are provided with a double ring oiling device. The cylinder is oiled by means of the oil hole at the inlet on the side, but the use of a sight-feed oil cup is recommended. Each blower is supplied with loose and tight pulleys, and can be driven either from an individual motor or from a line-shaft. When the machine is used as a blower, it will produce a maximum pressure of 10 pounds per square inch, but if it is in constant operation it is not advisable to run it at higher speed than to produce a pressure of 6 pounds per square inch. It is made in seven sizes known by the letters A, B, C, D, E, F and G. When used as blowers, the capacity of the various sizes varies from 17 cubic inches of air delivered per revolution for the smallest size, up

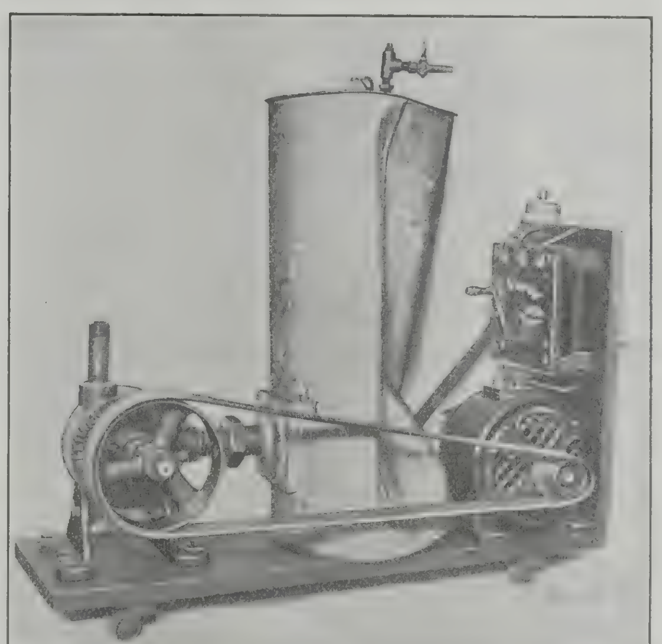


Fig. 2. Leiman Motor-driven Rotary Blower, having exhausted the air of an Internally-braced Tank, causing it to collapse

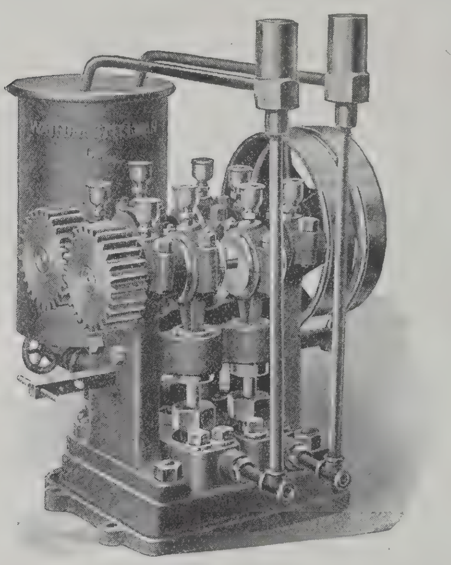
to 1,400 cubic inches for the largest size; the approximate horse-power for the smallest size is 1/10, and that for the largest size 2½. The maximum revolutions per minute vary from 600 on the smallest size to 200 on the largest, and the sizes of inlet and outlet from ½ to 2½ inches.

When used as a vacuum pump, the maximum vacuum is 20 inches, and the displacement per revolution corresponds to the air delivered per revolution by the machine when used as a blower. The approximate horse-power required for the vacuum pumps is the same as that for the blowers. The floor space of the smallest machine is 6 x 10 inches, and that of the largest 24 x 31 inches, the weight of the smallest being

only 20 pounds, while the weight of the largest size is 400 pounds. The vacuum pump is especially intended for all uses where a vacuum of 20 inches is sufficient for the required purpose, as, for example, in vacuum cleaners.

WATSON-STILLMAN SMALL HYDRAULIC PUMP

The accompanying illustration shows a four-cylinder hydraulic pump brought out by the Watson-Stillman Co., 192 Fulton St., New York. In the arrangement shown, two pressure lines are served independently of each other, from a common reservoir; but the type of pump illustrated permits of two, three or four pressure lines being independently served. Each pressure line has a separate pressure chamber, safety valve, and release line, and is served by a separate pair of cylinders with eccentrics set so as to produce a continuous flow. The diameter of the cylinders is ½ inch, by ½ inch stroke. Any pressure up to 600 pounds per square inch may be delivered into any line, the limit being determined by the setting of the safety valve which opens at excessive pressures and lets the surplus liquid through the release pipe to the reservoir. Any pressure line may be thrown out of service by opening the safety valve, in which case all the liquid will be pumped directly back into the reservoir. The design of the one, two, three and four pressure line pumps is practically the same, except, of course, that the bed-plate and the through shafts are longer. The pump may be provided with an electric motor instead of the fast and loose pulleys for belt drive shown in the illustration.



Four-cylinder, Two-pressure Line Small Hydraulic Pump, made by the Watson-Stillman Co. New York

STEEL SHELVING AND STORAGE EQUIPMENT FOR SHOP USE

The advantages of steel shelving in stock-rooms and store-rooms in machine shops are becoming more and more recognized. One of the most important advantages is the saving in space, as steel shelving requires to be but a fractional part of the thickness of wooden shelving to have an equivalent strength. It also reduces the fire hazard, is easier to keep clean, and the cost of maintenance is reduced to a very considerable extent. It is also possible to provide for interchangeability between the different racks and shelving systems in a way that is not possible when wooden shelving is used, and, in addition, it is easier to provide for adjustability as regards the height of the various shelves.

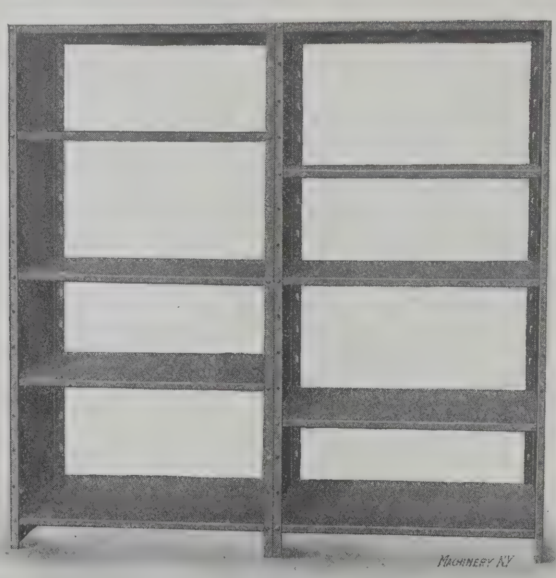


Fig. 1. Two Sections of Terrell's Steel Shelving for Shop Storage

Fig. 2. Rack especially adapted for Die and Tool Storage

The Terrell's Equipment Co., of Grand Rapids, Mich., has placed on the market a stock-room rack, bin rack and racks for die and tool storage, as well as a number of portable tool racks, trays and boxes provided with roller casters and with one or more shelves. In Fig. 1 are illustrated two sections of the regular stock-room rack. The end uprights are made of No. 20 gage steel, riveted to two strips of 1 by 1 by ⅛-inch reinforcing angles. In the front, the uprights are provided with holes for ¼-inch bolts, the vertical distances between the holes being 3¾ inches from center to center. In the back of the uprights, the angles are provided with catches stamped in them and located opposite the holes in the front. By this means rapid adjustment of the shelving is made possible, the space between the various shelves being adjustable to suit the tools stored upon them. This is clearly indicated in Fig. 1. The standard sizes of the uprights for this type of shelving are from 12 to 30 inches wide and from 3 to 15 feet high.

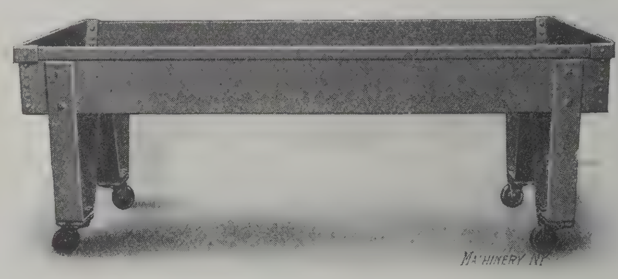


Fig. 3. Box for Material in Process of Manufacture, Tools and Finished Stock

Storage shelving for dies, tools, etc., is usually provided with a back as shown in Fig. 2. The backs are made of No. 18 gage steel and catches are stamped in the backs corresponding with the holes and catches in the uprights. This construction insures a close contact between the shelves and the back so that no material can fall down between. The shelves are made from 24 inches to 40 inches long, the width, of course, corresponding to that of the uprights. They are flanged on the sides and ends, and the front and back edges are double folded to provide for the required strength. In addition to this, the front edge is reinforced with a strip of ¾ by ¾ by ⅛ inch angle which is placed inside the fold.

In Fig. 4 is shown a portable tool rack which is made with or without the drawer shown. The corner posts of this tool rack are made of 1¼ by 1¼ by ⅛ inch angles. The trays are made of No. 16 gage steel, double folded at the top edges, and attached to the corner post with set-screws so that the whole arrangement can be easily taken apart and assembled, and thus be shipped "knocked down." The drawer is made of No. 18

gage steel and is attached to the bottom of the top tray by a steel slide, permitting the drawer to slide easily.

In Fig. 3 is shown a steel box placed on casters, which is made in a large variety of sizes and intended for stock-room, tool-room and shop use for raw material being in process of manufacture as well as for finished stock. The tray or box is made of different gages of steel according to the size. The sides and ends are triple folded and the corners provided with additional reinforcement.

CLEVELAND DRILL CHUCK

The drill chuck shown in the accompanying engraving has been placed on the market by the Cleveland Collet & Machine Co., Cleveland, Ohio. It is designed for holding a drill to the limit of its torsional strength, yet it is easily released by hand. No wrench is necessary as the resistance of the cut is utilized for increasing the grip on the drill, while, when the pressure is relieved, the jaws open easily by turning the chuck body by hand. The chuck consists of a shank part threaded into the knurled chuck body, to the end of which latter a tapered sleeve ring is attached. Three jaws slide with their back faces against the inside of the sleeve ring. The jaw holder rotates independently of the body only when a drill is not locked between the jaws; but when the drill is in place, it is locked in the jaw holder and the jaw holder in the sleeve by screwing up the chuck body on the shank, thereby producing the required pressure on the back of the jaws by means of the tapered surface in the sleeve ring. A ball thrust bearing is provided for taking the axial thrust, and in this manner the thrust on the thread on the shank is minimized. Another valuable feature of this ball bearing is that it prevents the drill and jaws from becoming so tightly gripped that it would not be possible to release the grip by the hand alone. The construction of the tool is simple, and as there are but few working parts, it is not likely to get out of order. This is an important consideration, as the time lost in repairs is often considerable when tools are unnecessarily complicated.

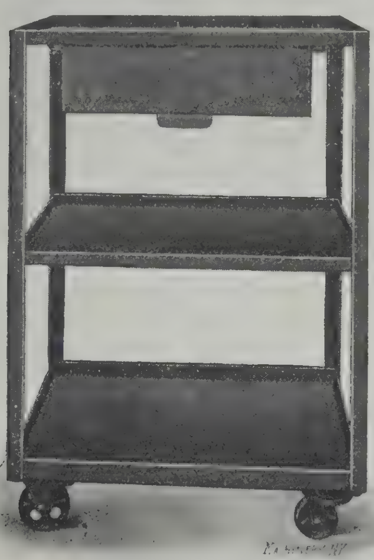
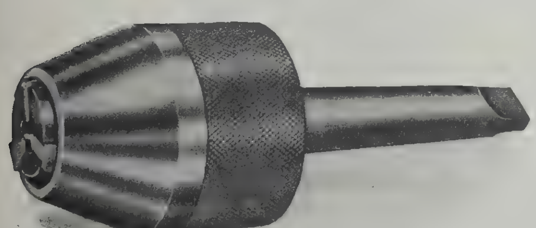


Fig. 4. Portable Tool and Storage Rack for the Shop



Drill Chuck made by the Cleveland Collet and Machine Co.

BLISS POWER PRESS FOR HEAVY COLD STAMPING

The straight-sided single-action press shown herewith was recently built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., for the Hydraulic Pressed Steel Co., of Cleveland, O. As indicated by the firm name of the customer, this tool was designed to replace the hydraulic machine on work of a character which has not hitherto been done by a crank machine. Its advantage, of course, lies in doing the work much more rapidly than is possible with hydraulic motive power, and more accurately as well, since the dies are bedded in long slides, gibbed with great care.

This press is of the makers built-up type, in which four vertical tie-rods of large diameter are depended on to receive the tensile stress imposed while the press is in operation, thus relieving the frame columns of all stress of this character. The columns are of heavy cross-section, giving great rigidity to the machine. Heavy extended feet are provided, so that ample stability is insured.

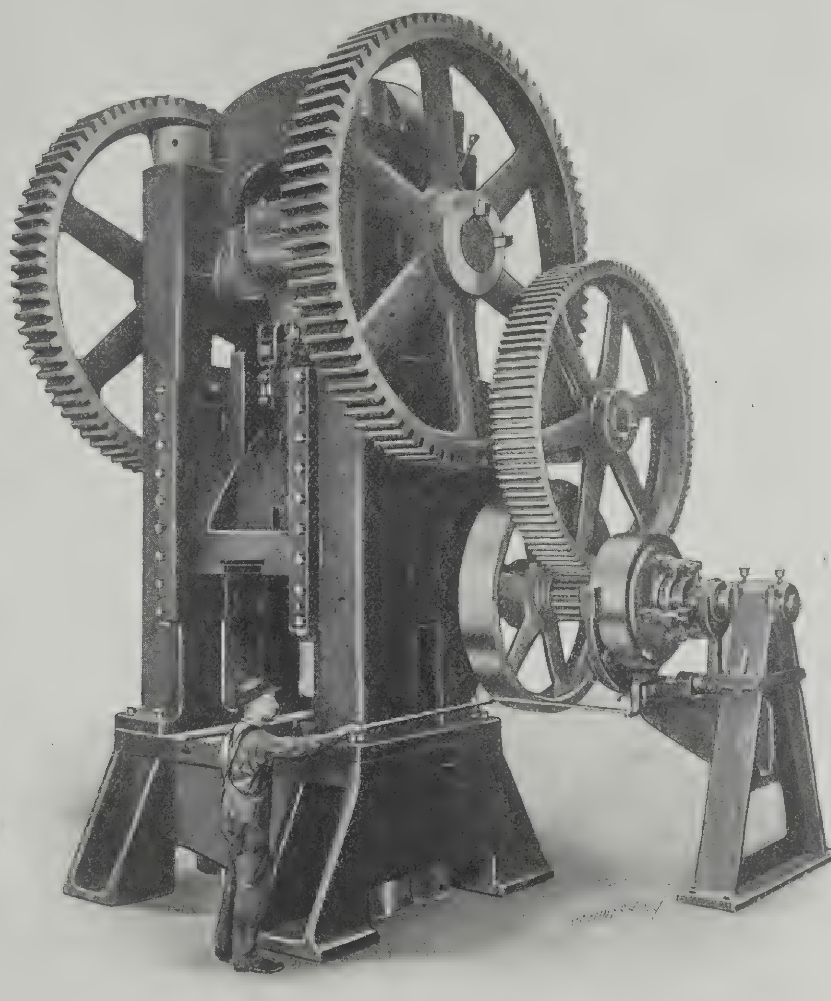


Fig. 1. A Crank Press designed for Work formerly done on the Hydraulic Press

Some idea of the massiveness of the construction may be obtained from Fig. 3, which shows the slide, weighing over seven tons. Fig. 2 shows the crankshaft with its two main gears, one at each end. These weigh over 6 tons apiece. The double drive reduces the bending and torsional strain on the crankshaft. The driving gearing throughout is of steel, compactly arranged, and with machine cut teeth. The machine is controlled by a hand-lever, operating a combined friction clutch and brake. The clutch is of improved type with heavy rigid friction surfaces, arranged to be relieved of rubbing contact when not driving. A safety coupling attached to the fly-wheel permits it to free itself in case the press is subjected, through accident or carelessness, to a pressure greatly in excess to that for which it is intended.

The bed of this machine has an area of 60 by 48 inches. The crankshaft is 16 inches in diameter. The total weight is 164,000 pounds. It is believed to be the largest machine of its type ever built. Large double crank presses and drawing presses are not unusual, but this tool is designed to enter a

new field for the power press, in the cold forming of sheet metal of extra heavy gages. It is particularly adapted to such work as stamping sheet steel brake drums, axle housings, etc., for automobiles. On such work it gives more accurate results and a much higher production than the hydraulic press can attain.

BEAMAN & SMITH NO. 10 BORING AND MILLING MACHINE

The tool herewith illustrated and described is made by the Beaman & Smith Co., of Providence, R. I. It is of the type which has come into such extensive and well-deserved popularity in the past decade, in which the work is mounted on a table provided with longitudinal and cross movements, while the spindle is mounted in a saddle which may be adjusted

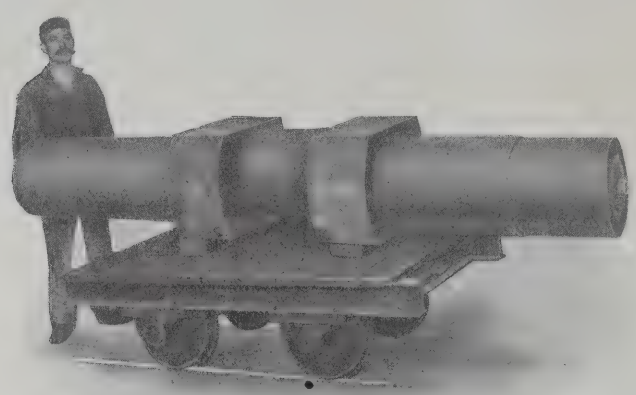


Fig. 2. A Crankshaft 15 inches in Diameter

or fed vertically on the face of an upright column. This arrangement supports the work and the boring-bar under the most favorable conditions for a wide range of operations.

A distinctive point in the design will be seen at once from an inspection of the engraving. This relates to the form of all the main castings of the machine. A tubular section has been used throughout, this being applied to the bed, the column, the outboard bearing and the feed bracket for the boring-bar. It is not necessary to expatiate on the stiffness of this form of section in resisting torsional strains or bending strains. It would seem to be especially suited for machine members of this kind, and its use gives the whole machine a distinctive and pleasing appearance, which is even more evident in the machine itself than in the photograph which we have reproduced.

The feed and speed changes are obtained by gearing from a constant speed pulley. There are 18 changes of speed, obtained through the gear-box shown at the extreme right of the engraving, in conjunction with the back-gear handle shown projecting through an opening in the gear guard at the top of the saddle. The changes range from 4.34 to 125 revolutions per minute, giving suitable speeds for the drilling of small holes and for large facing or heavy milling operations as well. Ample power is provided by the 5-inch belt drive on the 14-inch pulley, running at 230 revolutions per minute. The gearing ratios vary from 1 to 1.8 for the fastest speed, up to 1 to 52.5 turns of the pulley to one of the spindle for the slowest speed given above. The spindle has a No. 5 Morse taper hole with a driving slot across the end.

The boring-bar has a continuous traverse of 30 inches and a maximum traverse of 60 inches by shifting its position. Eight feeds are provided, operated by the quick change gear mechanism shown at the foot of the column. These range from 0.009 to 0.252 inch per revolution of the spindle for drilling and boring. For milling, the speeds range from 0.56

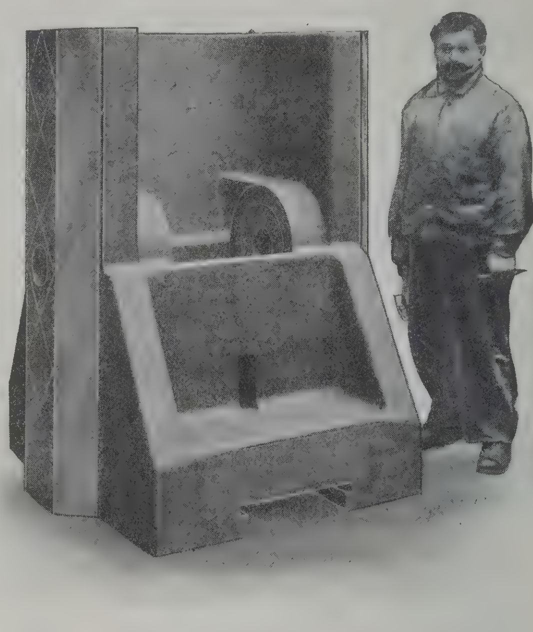


Fig. 3. A Massive Slide, weighing over Seven Tons

to 15.7 inches per minute at any spindle speed. It will be seen from this that the feed is connected with the constant speed driving shaft when milling, and with the spindle when drilling and boring, so that the arrangement of the feeds is exactly suited to each of these two operations. This construction is, so far as we know, a new one in machine tool design, machines having hitherto been constructed so that one of the two connections was made, but not so that both of them were available. For milling, the feeds are applicable to the cross-

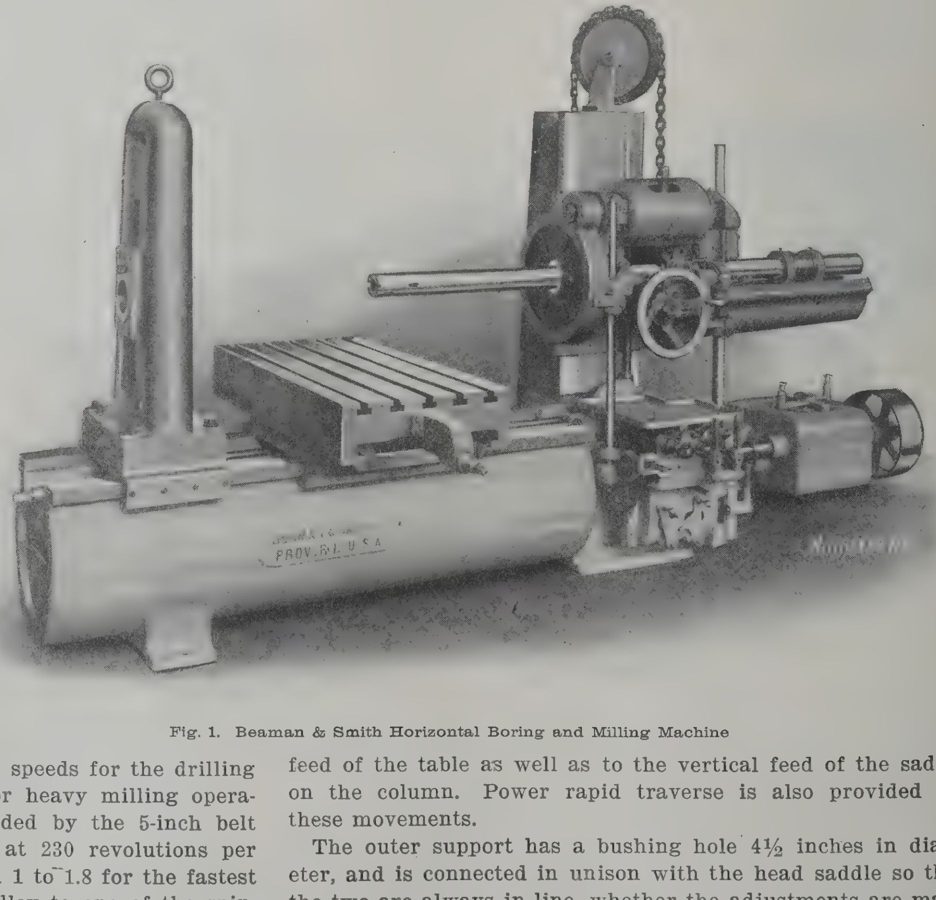


Fig. 1. Beaman & Smith Horizontal Boring and Milling Machine

feed of the table as well as to the vertical feed of the saddle on the column. Power rapid traverse is also provided for these movements.

The outer support has a bushing hole $4\frac{1}{2}$ inches in diameter, and is connected in unison with the head saddle so that the two are always in line, whether the adjustments are made by hand or power. The bushing block is carried between uprights, instead of on the side, so that the maximum of rigidity

is provided. Longitudinal adjustment on the bed is effected by a screw.

The general construction of the machine is of the highest grade. The sliding surfaces are accurately scraped. The adjusting screws are of generous dimensions. All gearing is cut from the solid, the bevel gears being generated by the Bilgram process. Bearings are bronze lined, wherever necessary. Spindles and shafts are accurately ground to size. As to the capacity of the machine, the least distance from the center of the spindle to the top of the table is 3 inches, and the greatest 25 inches; the vertical adjustment is 22 inches. From the spindle driving gear, which is 18 inches in diameter, to the outer support, the shortest distance is 27 inches and the greatest 5 feet 6 inches. The 24- by 48-inch table has a cross feed of 36 inches and a longitudinal movement on the bed of 40 inches. The weight of the machine is approximately 11,000 pounds.

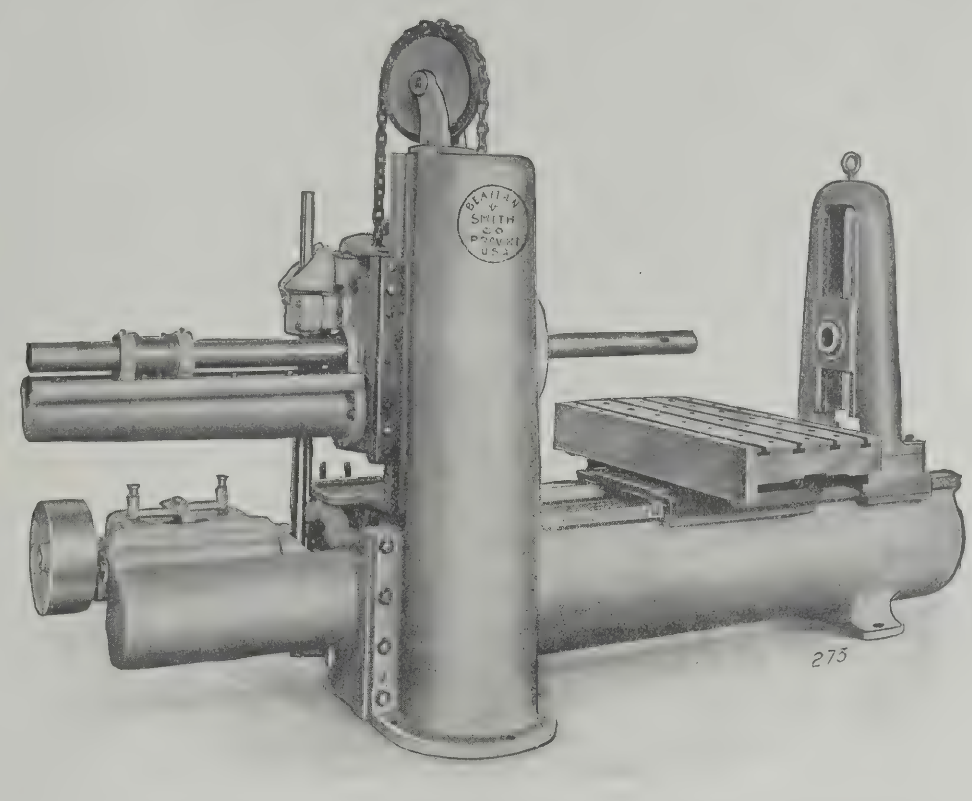
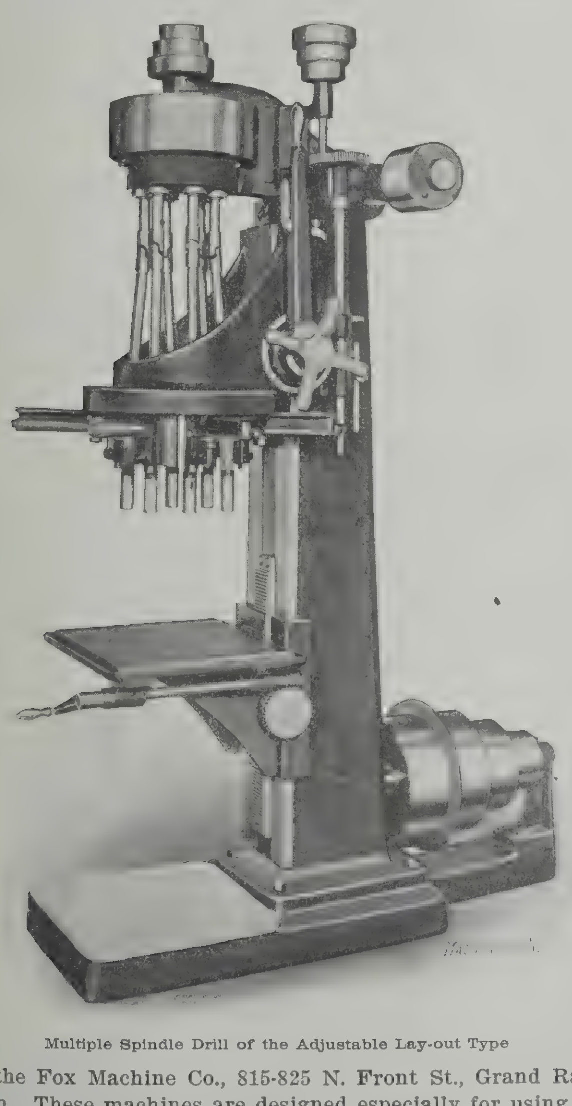


Fig. 2. Rear View showing Tubular Section used throughout in the Construction of Machine Members

FOX MULTIPLE SPINDLE DRILL

The tool herewith illustrated is one of a line of multiple spindle drilling machines built



Multiple Spindle Drill of the Adjustable Lay-out Type

by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich. These machines are designed especially for using high-speed drills, and will be found useful for automobile and gas engine work, and for general manufacturing.

The particular machine illustrated is the No. 1 size, provided with a round head. This is fed downward along the face of the column, inside of which is a weight for counterbalancing the movement. The power feed movement of 5 inches is transmitted through the swinging vertical shaft, which carries a worm engaging a worm-wheel on a rack pinion shaft. An automatic knock-off disengages the gearing at the end of the drilling operation. The hand lever shown provides for manual operation in the case of light work.

An exclusive feature of this machine is the design of the spindle bearings, mounted on the adjustable supporting arms. The construction gives a long stiff bearing, and one which is at the same time adjustable in a vertical direction without disturbing the setting of the other spindles. Patents are pending on this construction.

The base of this machine is 4 feet 6 inches by 18 inches. The table is 16 by 16 inches, having a vertical adjustment by a worm and worm-gear as shown in the engraving. Three spindle speeds are provided—262, 525 and 1050 revolutions per minute, respectively. The automatic feed has three changes, giving 0.0038, 0.0059, 0.0098 inch per revolution of the spindles, respectively. The driving connections by which these changes of feed and speed are obtained are exceedingly simple, and will be readily understood from the engraving.

* * *

During the month of August, 194 automobiles valued at $333,960 and parts valued at $114,973 were imported into the United States. Of the 194 cars imported, 109 came from France, 52 from Italy, 9 from Germany, 8 from the United Kingdom, and 16 from other countries. During the same month 360 automobiles were exported, valued at $567,964. During the first eight months of the year 2,140 cars, valued at $5,107,953 were exported. An interesting thing to note is the high average price of the exported cars, which is about $2,500, indicating that the United States is rapidly taking a place among the nations exporting high grade automobiles.

* * *

The ordinary incandescent lamp with carbon filament requires about 3 watts per candle-power; the incandescent lamp with tungsten filament, 1.25 watt; the arc lamp, 1 watt; and the Cooper-Hewitt mercury vapor lamp ½ watt.

NEW MACHINERY AND TOOLS NOTES

No. 7 Disk Grinder: Gardner Machine Co., Beloit, Wis. This is a disk grinder of the same design as followed by the maker in the older members of his line, but intended for larger disks up to 30 inches in diameter. Greater belt power is also provided.

Furnace for Lead and Cyanide Baths: United States Gas Furnace Co., Providence, R. I. This furnace is intended particularly for heating baths of various substances for hardening steel parts. When used for lead, an open fire is permitted, but for cyanide a hood is fitted to carry the fumes away.

Die Sharpening Machine: National Machinery Co., Tiffin, O. This little tool is designed for threading dies or chasers for bolt and pipe work. It grinds these dies to uniform depth, giving them a proper cutting angle and clearance, so that each chaser will have the same amount of work to do. A 6-inch wheel is used, mounted on a spindle running in bronze bearings. Suitable graduations are provided for setting the machine.

Small Motor-Driven Shaper: L. E. Rhodes, Hartford, Conn. The Rhodes small shaper is now provided by its makers with a substantial iron base and a motor-drive, whenever required by the customer. A Lincoln motor is used, giving a 6 to 1 speed range; it is connected to the driving shaft by chain and sprockets. This combination should be useful in manual training schools, for model makers and others whose work is similar.

Oxy-acetylene Welding Apparatus: Oxy-Carbi Co., New Haven, Conn. This firm makes apparatus for the continuous generation of oxy-acetylene under suitable control, so as to be generated and mixed at the time it is used. The apparatus is made in either portable or stationary form. Suitable welding and cutting torches are furnished for the wide variety of work for which this process has been found adapted in the past two or three years.

Alligator and Combination Wrenches: W. S. Ducharme, Johnstown, Pa. The combination wrench made by this firm may be used as a pair of pliers or as a screw-driver, in addition to its use as a wrench. As a wrench it is self-adjustable, the jaws automatically closing as the pull increases. The alligator wrench is also adjustable, by means of a thumbscrew, adapting it to a wide range of sizes. A reversible jaw allows the wrench to be used in either direction.

Precision Spirit Level: Izard-Warren Co., 136 No. 12th St., Philadelphia, Pa. This style of precision level is built in six sizes, ranging from 2 to 24 inches in length. The bulbs are carefully made and are so ground as to indicate a variation of one-thousandth inch in the length of the level. A cross bulb is provided to make sure of the proper setting of the instrument. The body is of cast iron and the top of brass. The tool goes under the name of "Sterling Machinists' Precision Level."

Motor-Driven Precision Lathe Outfit: Rivett Lathe Mfg. Co., Brighton, Boston, Mass. This is a Rivett precision lathe mounted on a special cabinet with countershafts, etc., and a motor-drive enclosed in the base. The cabinet is of quartered oak, nicely finished, with a top surface which takes the place of the work bench on which the lathe is usually mounted. The whole arrangement provides places for the storing of attachments, tools, etc., in a way that is very convenient for a user of a precision tool.

Cold Heading Machine: Waterbury Farrell Foundry & Machine Co., Waterbury, Conn. This firm has lately produced what is supposed to be the largest cold heading machine made, being adapted to automatically produce work up to 7/8 inch in diameter and 4 inches long. The weight of the machine is over 42,000 pounds. It embodies the principles of the smaller machines of the same line, but changes have been made in details to cover the greater massiveness and rigidity required for heavy operations.

Improved Bevel Protractor: L. S. Starrett Co., Athol, Mass. This protractor is intended to be a member of the makers' well-known combination square sets, being used in connection with a graduated rule or straightedge. The improvement in the construction consists in the fact that its head extends on both sides of the blade, permitting angles to be transferred from either side of the frame without resetting. The readings indicate the supplement of the angle as well as the angle itself, thus facilitating the use of the tool.

Punch Press: Atlas Machine Co., Waterbury, Conn. This is a power-driven machine designed for light punching and stamping operations, and intended to take the place of the orthodox foot press, producing a more even pressure and more uniform work, and obviating the fatigue of the operator. The machine is controlled by a one-revolution clutch, connected to a treadle. The distance from the top of the bed to the lower end of the ways is 6 inches. The bed surface is 7½ by 12 inches. The total weight of the press complete is 500 pounds.

Scroll Chucks with Adjustable Jaws: D. E. Whiton Machine Co., New London, Conn. These tools are really a combination of independent and scroll chucks, inasmuch as they permit an individual adjustment for each jaw, this being provided by a screw mounted in the base of each which adjusts the scroll nut with relation to the jaw. This arrangement permits keeping the chuck true, without repeated grinding or boring of the jaw faces. These tools are also made with four jaws, so located that they may be used either as two-jaw or three-jaw chucks.

Adjustable Planer Gage: Tip Top Tool Co., 78 Vernon St., Worcester, Mass. This planer gage is of the type in which an anvil is adjusted up or down the inclined surface of a wedge, so as to form a measuring block having parallel surfaces which may be set for any distance apart from 3/16 inch to 1½ inch. This wide range is permitted by the fact that the measuring block has two steps of different heights. No graduations are furnished, it being designed to set the block by the aid of micrometer calipers. A fine adjustment is provided similar to that used on vernier calipers.

Nine-Spindle Milling Machine: Beaman & Smith Co., Providence, R. I. This firm has recently equipped its planer type of milling machines with a set of special heads carrying nine spindles. The side heads are provided with three spindles each, and the crossrail head has two on the front and one in the rear. This arrangement permits the machining simultaneously of the sides of the flange of automobile cylinders, the faces of the upper and lower valve openings, the spark plug boss and the inlet and exhaust connection bosses. The time required for finishing them is thus materially reduced.

Hack-Saw: Massachusetts Saw Works, Chicopee, Mass. This saw has a number of improvements in construction, of which the most notable one is a provision for adjusting the stroke automatically with the size of the work, so as to use, at all times, the full length of the saw blade. This adjustment is connected with the sliding vise jaw, so that no attention is required to it on the part of the operator. The blade is automatically relieved on the return stroke, which is made with an increased speed, due to the use of a quick-return mechanism. An automatic knock-off is provided to stop the machine when the cut is finished.

Universal Collet: Cleveland Collet & Machine Co., Cleveland, O. This is a chuck or collet of the draw-in type, intended for application to the engine lathe. Its principal advantage lies in the fact that it is adjustable for a wide range of work, it not being necessary to provide a large number of separate spring collets to cover the range, as is usual. The work is held by jaws which are opened or closed for a change in diameters, in a manner somewhat similar to the ordinary scroll chuck. The tightening of these jaws on the work, however, is effected as usual by a handwheel at the rear end of the spindle, acting on a tube passing through the latter.

Coil Clutch: Farrel Foundry & Machine Co., Ansonia, Conn. This clutch is of the type in which frictional contact is produced by the tightening of a heavy steel spring, which forms one member, about a drum or barrel, which forms the second member. As is well-known, this construction gives a very heavy gripping power for a slight pressure in the tightening of the spring. This particular design has been built for powers as high as 8,000 at 60 revolutions per minute in one English installation. The spring is hand-forged from a high-grade of steel and the drum is of chilled iron, making a very durable and substantial construction. The line covers a wide range of sizes.

Variable Speed Sensitive Drill Press: Villinger Mfg. Co., Williamsport, Pa. This drill press is a simple machine with a number of new features, among them being a connection of the feeding handle with a friction disk drive in such a way that this handle serves to vary the rate of speed as well as to feed the drill. Pushing the handle to right or left changes the speed, while drawing it down feeds the drill as usual. In addition, connections are provided which stop the spindle when the feed lever is turned back to its upright position. A key is provided which holds the table central with the drill at whatever vertical height it is adjusted. This key can be withdrawn, however, to permit swinging the table from one side to the other as may be required for special cases.

Crank Planing Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This is a tool which has found much favor in railroad and locomotive shops and other places where cuts are to be taken on comparatively small pieces of tough metal. The framework of the machine is of the planer type, but the table is actuated by a crank motion of variable stroke driven by a Whitworth quick return movement, similar to that used in many designs of shapers. The saddle is provided with power cross-feed on the rail, and the tool slide has a vertical or angular down feed on its slide. The machine is very strongly and ruggedly built, and is capable of taking heavy cuts, owing to the fact that all cutting strains are rigidly resisted by the disposition of the metal in the framework.

Cam Grinding Attachment for Standard Grinding Machines: Norton Grinding Co., Worcester, Mass. This attachment may be applied to the maker's standard type of grinding

machine. The desired outlines on the surfaces to be ground are produced by master cams or templets, which swing the work in toward the wheel or away from it as may be required to give the desired contour. A series of templets is provided, one for each of the different cams on the shaft, so that each is of the proper shape and properly located to give the correct timing. The whole arrangement is very simple, and easily applied and operated. It should result also in the production of cam surfaces of a high grade of accuracy. Provision is made in the device for grinding the templets or master cams from models, which are thus exactly reproduced in the contour of the work.

Blueprint Storage Tube: G. Chalmers Brown, New London, Conn. This tube is intended for the storage and use of blueprint paper from the roll. It may be fastened to a bench or side of the wall. The roll of paper is inserted in the end of an inner tube, after which this inner tube is turned around so that the opening in its side is out of line with the opening in the outer tube. The paper is thus safely sealed against the entrance of light. In removing the paper, the inner tube is turned around until the openings register and the paper is pulled out through the slot thus provided. A tape-measure is mounted on the apparatus which is pulled out at the same time with the paper, accurately measuring the length of the sheet removed. The paper is torn by drawing it cornerwise across the sharp edge of the opening. This tube should find favor on the score of economy and convenience in the use of blueprint paper.

36-Inch Radial Drill: Dreses Machine Tool Co., Cincinnati, O. This machine resembles the previous designs of the same builders in the construction of the spindle head, feed, etc. It is provided, however, with a new driving connection between the horizontal shaft on the arm and the vertical shaft inside the column, which does away with a considerable amount of mechanism, including two spur gears, a shaft and two bearings. The elevating screw is placed in a recess in the front of the column where it does not lessen the swing of the machine. An improved clamping device is provided which binds the column, the table and the stump together by a single movement of the lever. The table may be adjusted to keep it always perpendicular to the spindle. The machine will be furnished either with cone pulley or gearbox drive, or with constant or variable speed motor drive. It drills to the center of 73-inch circles, takes 78 inches between the center and the base and weighs about 3,600 pounds.

Lester Automatic Screw Machine: Davis Sewing Machine Co., Dayton, O. This is a multiple spindle machine involving a number of novel features in its construction. For one thing, it has three stock spindles in place of the usual four or five. The indexing and cam movements are so arranged that these three spindles, on simple work, can be made to form three pieces at each revolution of the cams, without indexing; these pieces may be alike or different as may be required. On plain work, it may thus be seen, the machine has a very high capacity. Another new point in the design is the large number of tools provided. There are six stations in the tool-holder and three cross-slide tools, this making nine cutting operations possible for each piece; and as many of these operations may be arranged to make use of multiple cuts, the range of work to which the machine is adapted is very large. The size of machine at present built has a capacity for stock up to 1 inch diameter, and a length of feed for turning up to 4 inches.

Machine for Testing Running Balance: The Norton Grinding Co., Worcester, Mass. The obtaining of standing balance in a rotating part is a comparatively simple operation, it being common to roll the work along knife edges or between centers, and mark the heavy side as indicated by the position in which the part comes to rest. The obtaining of a running balance, however, is another matter. It has always been done by homemade contrivances, more or less clumsy and slow. The Norton Grinding Co. has recently devised a piece of apparatus for this work which greatly simplifies the operation and permits it to be done much more quickly and accurately than ever before. Briefly, the part to be tested is provided with two supports, one on each end, on which it is rotated rapidly by an electric motor. These supports are floating, and indicate every vibration by means of a lever magnifying arrangement. Provision is made for marking the high side at each support to show the running out permitted by the floating bearing. By reversing the rate of ratio the lag due to the inertia of the floating and indicating parts is compensated for. For long and slender work provision is made for supporting and indicating at one or more intermediate points as well as at the ends. The whole apparatus is well-designed and conveniently arranged, and should prove especially useful in automobile work, high-speed drums and pulleys, and in woodworking machinery building in general.

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The Pennsylvania R. R. tunnels from Bergen Hill, N. J., to Long Island City were practically completed December 3 when the final section of concrete was placed in line D, the fourth and last of the tunnels under the East River, to the Sunnyside Yard, Long Island City.

GEORGE WESTINGHOUSE

ARTHUR WARREN

The new president of the American Society of Mechanical Engineers needs no introduction to engineers of any branch, nor to the general public the world over. He has been famous and honored everywhere these forty years, for it was in 1868, and at the age of twenty-two, that he brought forward his great invention, the air brake, which it has been said "ranks next to the press and the locomotive among those forces to which the material developments of the present age primarily are due." The evolution of the air brake under his personal inventiveness in the years that have passed since he first originated the device has made the modern railroad possible. Without the control which the air brake gives, high speed, frequent service, long trains, huge cars, heavy loads, would be unknown. The air brake, therefore, is not only a safety device; it is also a most important operating device on a railroad.

George Westinghouse was born October 6, 1846, at Central Bridge, Schoharie County, in the state of New York, a son of George and Emeline Vedder Westinghouse. His father was a manufacturer of agricultural machinery at Schenectady. Out of school hours the boy taught himself engineering, and it was his idea of a holiday and a vacation to work in his father's machine shop. Before he was seventeen he enlisted for the Civil War, serving first in an infantry regiment and next with the cavalry. Then, passing an examination for the purpose, he was transferred to the Navy where he served during the remainder of the war as an Assistant Engineer. In the same year that he returned to civil life, 1865, he entered Union College and invented a device for placing derailed cars on the track. Three years later he thought out and patented the air brake. He had to guarantee the railroad which made the first trial with the brake that he would pay for any damage that might be done to the train as a result of equipping it with the apparatus and running a trial trip. Instead of damaging the train, his brake prevented a fatal accident on the trial run and then the skeptical railroad officials expressed astonishment and enthusiasm, and men who had thought it "impossible to stop a train with air" were eager to buy the invention.

Young Westinghouse, however, declined to sell. He formed a company, took a workshop in Garrison Alley, Pittsburg, and began to manufacture the remarkable contrivance which he had invented. In a year the new works had thirty-six employes, including clerks and office boy. From that modest beginning have grown the great works of the Westinghouse Air Brake Co. at Wilmerding, Pa., and the town of Wilmerding itself. From the fruits of the inventor's genius, energy and capacity as an organizer of industry have developed thirty companies, of which he is president, employing 50,000 men, $120,000,000 of capital, and manufactories at East Pittsburg, Swissvale, Trafford City, and Wilmerding, in Pennsylvania, in London and Manchester, England, and in

France, Germany, Italy, Austria and Russia. There is not a civilized country in which the name Westinghouse is not familiar. Air brakes, electric motors and generators, steam and gas engines, steam turbines, railroad switches and signals, and a multitude of other things testify to the inventive and industrial energy of this distinguished man.

After inventing the brake he took up the study of railroad signals and switches and showed how these could be operated with compressed air. Having done this, he combined electricity with the pneumatic operation of these devices. Thus he was led further and further into the pursuit of the then new electrical art. Convinced of the practicability of conveying electrical currents over great distances, he resolved to develop the alternating system for that purpose. From Europe he acquired the patents of Gaulard and Gibbs. He brought Tesla to Pittsburg, backed him financially, placed laboratory and workshop facilities at his disposal, and the result was the invention of the induction motor for utilizing the alternating current for power purposes.

The great successes of Mr. Westinghouse have not been gained without opposition. His strength of character, mind and resource, however, has always been brought forth in encounters, and he has always won. Opposition to the alternating current system developed to an extraordinary extent. Men who should have known better, and do now, declared that the alternating current was impracticable, and that if ever made practicable its use would be deadly and a menace to the public welfare. Legislation was invoked against it in many states. These efforts were really meant to be, whatever the legislators may have thought, a systematic attempt to check George Westinghouse in his plans for bringing electricity within the reach of all. And to prove to the populace the "danger" of the system which he advocated, some of the opponents prevailed upon the authorities to use an electrical death-chair for the execution of convicted murderers! The originators of this brilliant idea, and of the campaign against the alternating current system, found themselves as impotent as King Canute when he commanded the incoming sea to retreat. Scientifically, commercially, and in every way, the alternating system proved to be what the world required for the general adoption of electric currents on a large scale, and the opposition was defeated. Similarly, in the hard times of the early nineties, men who desired to monopolize the manufacture of electrical machinery took advantage of the generally depressed conditions of affairs throughout the country, and endeavored to drive Mr. Westinghouse into a corner, and to obtain control of the electrical manufacturing company which he had founded, organized and built up into a great center of industry; but the attempt to overcome him was unsuccessful. The panic of 1907 caused a renewal of this kind of attack, but as Andrew Carnegie is reported to have said, "George Westinghouse is a genius. You cannot keep him down!" What is more, you cannot get him down. He is one of the world's strong men.

At the time of the Chicago exhibition the electrical illuminations of that vast and beautiful undertaking were the most remarkable that had ever been seen. George Westinghouse offered to take the electrical contract for a million dollars less than the figure which the exposition authorities were on the point of agreeing to pay the bidders who seemed to be the most successful. "It cannot be done," the competing bidders said to the exposition authorities. "But I will do it," said Westinghouse. And then they undertook to show that they monopolized the lamp patents of that time. This they thought would make him powerless in the matter, but he persuaded the authorities to postpone the decision, and they, glad enough to save a million dollars, and having faith in the man, consented to the postponement. Mr. Westinghouse returned to Pittsburg, invented a lamp, returned to Chicago, secured the contract and saved the exposition a million.

George Westinghouse has invented many things, and has encouraged invention in the engineers associated with him.

He devised a system for mechanically controlling the flow of natural gas, and piping it over long distances for use as fuel in the industries and homes of Pittsburg. He built the first ten great generators for Niagara, and those for the elevated and subway lines in New York, and for the Metropolitan Railway in London. It is impossible within the present space to enumerate either his inventions or his business achievements. His work has frequently taken him into many countries, and distinguished men of all callings and sciences are, and long have been, among his personal friends. Of these, Lord Kelvin was the first recipient of the John Fritz medal. George Westinghouse, by the way, was the second person to receive the John Fritz medal. The French Republic, the late King Leopold of Belgium, and the late King Humbert of Italy decorated Mr. Westinghouse. The Königliche Technische Hochschule of Berlin gave him the degree of Doctor of Engineering. He was, in 1905, selected as one of the three trustees to hold the voting power of the stock control of the Equitable Assurance Society, being associated in this important trust with ex-President Grover Cleveland, and Justice Morgan J. O'Brien. He is president of the American Society of Mechanical Engineers, is one of the two honorary members of the American Association for the Advancement of Science, and an honorary member of the National Electric Light Association.

The latest activity of Mr. Westinghouse is the bringing before the attention of the marine engineers of America and Europe the reduction gearing and "floating frame" invented by Rear-Admiral Melville, ex-Engineer-in-Chief, U. S. N., and John H. Macalpine. The purpose of this invention is to enable high-speed steam turbines to drive the propellers of steam vessels, thus obtaining from the propellers and the turbines their highest efficiency. Mr. Westinghouse supplied the means for constructing and testing this important invention, and at the same time developed a marine turbine of his own which is said to be a great improvement over any now in use. This turbine has been used in the tests of the Melville-Macalpine gear, tests which are reported to be of a remarkably satisfactory character.

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ANNUAL MEETING OF THE A. S. M. E.

The thirtieth annual meeting of the American Society of Mechanical Engineers was held in New York, December 7 to 10 inclusive, the Engineering Societies Building, 29 West 39th St., being the headquarters. The registration of members was 638, and including guests, 1063. The program was substantially as follows:

Tuesday.—President Smith's address, "The Profession of Engineering," and the introduction of President-elect George Westinghouse, followed by a reception held by the president, president-elect, Secretary Rice and Honorary Secretary Hutton with their ladies.

Wednesday.—Annual business meeting, reports of membership, standing and special committees and gas power section. In the afternoon a large party went through the new Pennsylvania R. R. terminal and passenger station at 7th Ave. and 31st and 33d Sts. In the evening an interesting stereopticon lecture was delivered by L. W. Ellis of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C., entitled "The Era of Farm Machinery."

Thursday.—"Tests on a Venturi Meter for Boiler Feed" by Charles M. Allen; "Pitot Tube as a Steam Meter" by George F. Gebhardt; "Efficiency Tests of Steam Nozzles" by F. H. Sibley and T. S. Kemble; "Electric Gas Meter" by C. C. Thomas; "Tan Bark as a Boiler Fuel" by David M. Myers; "Cooling Towers for Steam and Gas Power Plants" by J. R. Bibbins; "Governing Rolling Mill Engines" by W. P. Caine; "Experience with Leaky Vertical Fire Tube Boilers" by F. W. Dean; "The Best Form of Longitudinal Joint for Boilers" by F. W. Dean; "Testing Suction Gas Producers with a Koerting Ejector" by C. M. Garland, A. P. Kratz;; "Bituminous Gas Producers" by J. R. Bibbins. In the evening the members of New York and vicinity gave a reception to the officers and members of the society, their ladies and guests at the Hotel Astor.

Friday.—"The Bucyrus Locomotive Pile Driver" by Walter Ferris; "Line Shaft Efficiency, Mechanical and Economic" by Henry Hess; "Pump Valves and Valve Areas" by A. F. Nagle; "A Report on Cast Iron Test Bars" by A. F. Nagle.

Besides the excursion mentioned there were other excursions of much interest as follows:

International Steam Pump Co., Harrison, N. J., to inspect a modern plant for the manufacture of pump and hydraulic machinery; General Electric Co., Harrison, N. J., to inspect incandescent lamp manufacture; Interborough Rapid Transit Co., W. 58th and 59th Sts. and west side of 11th Ave., to inspect a large central electric light and power station for public service; National Phonograph Co., Orange, N. J., to inspect the manufacture of Edison phonographs and records; De La Vergne Machine Co., E. 138th St., New York, to inspect a new type of oil engine; New York Telephone Co., 61 Irving Place, New York, to inspect the Gramercy and Stuyvesant central telephone exchanges; Crocker-Wheeler Co., Ampere, N. J., to inspect a modern plant for the manufacture of electric generators and motors; Westinghouse Lamp Co., Bloomfield, N. J., to inspect incandescent lamp manufacture; New York Edison Co., E. 38th to E. 40th Sts., New York, to inspect the Waterside electric light and power stations Nos. 1 and 2 for public and private service; Brooklyn Rapid Transit Co., Kent Ave. and Division St., Brooklyn, to inspect a modern central electric power station for public service; Rockland Electric Co., Hillburn, N. J., to inspect gas engines and producers in a modern public service plant; Singer Mfg. Co., 149 Broadway, to inspect the power plant and view the city from the tower 548 feet above the street; Trenton Iron Co., Trenton, N. J., to inspect a modern electric generator plant operated by gas engines; Watson-Stillman Co., Aldene, N. J., to inspect a 300 horse-power Riverside gas engine operating in connection with a Tait producer; Metropolitan Life Insurance Co., E. 23d St. and 4th Ave., to inspect the power plant and view the city from the tower.

The excursion through the Pennsylvania R. R. terminal was of extraordinary interest. The terminal, which is part of one of the world's greatest engineering works, occupies four blocks in the heart of New York, lying between 31st and 33d Sts. and 7th and 9th Aves. It is 784 feet long and 430 wide. Its average height above the street is 69 feet, and maximum height 153 feet. The main waiting room is 277 feet long, 103 feet wide and 150 feet high in the dome. At the track level the station covers an area of 7.74 acres and the total trackage is 16 miles. The number of standing tracks at the station is 21, and the number of passenger platforms is 11. The power house adjacent has a boiler capacity of 5,000 H. P.

The New York terminal extension consists of the Pennsylvania R. R. Tunnel and Terminal Roads forming a connection with the New York division of the Pennsylvania R. R. near Harrison, N. J., which runs over the meadows, under Bergen Hill, North River, Borough of Manhattan and East River through the Sunnyside yards to the Long Island Railroad near Woodside Ave., Queens Borough, Long Island. The total length of the extension is 14.9 miles, including 1.25 mile in the Harrison yard. Of this, 2.78 miles are land tunnels, 2.29 miles river tunnels. The terminal is really a way station on the connecting link between the Pennsylvania R. R. system and the Long Island Railroad system. The terminal building is a beautiful structure lined with Carrara marble and of most impressive proportions.

The large number of interesting excursions and other extraneous features incident to the meeting tended to detract from the value of the technical proceedings. The members generally neglected the sessions, the result being that they were poorly attended and the discussions largely perfunctory. It is a question whether a programme of papers could have been prepared that would have drawn more attendance in view of the manifold outside attractions. If not, it would seem that a change should be instituted in the entertainment and conduct of the meetings if the best interests of the society are to be conserved.

The following officers were elected: George Westinghouse, president; Charles Whiting Baker, W. F. M. Goss, E. D. Meier, vice-presidents; J. Sellers Bancroft, James Hartness, H. G. Reist, managers; William H. Wiley, treasurer.

* * *

Don't use wet or green timbers for countershaft hanging, without tightening up the bolts every week or two, for a while.

PERSONALS

H. L. Pelz is now foreman of the foundry of the Chicago & Alton R. R. at Bloomington, Ill.

L. Fleishfien has been put in charge of the machine department of the Chicago & Alton R. R. shops at Bloomington, Ill.

Fred H. Robinson, with the Bailey Automobile Co., Springfield, Mass., has been promoted to position of foreman of the machine shop.

A. L. Myers, a department foreman of the LeBlond Machine Tool Co., Cincinnati, Ohio, has been made assistant superintendent.

Walter C. English, manager of the Boston office of the *Iron Age* and associated publications, has retired after twenty-six years of service.

C. L. Woodward, mechanical engineer and designer, of the Bailey Automobile Co., Springfield, Mass., has been appointed superintendent of the factory.

The headquarters of Ethan Viall, western editor of MACHINERY, will be 1811 First National Bank Building, Cincinnati, Ohio, after January 15.

J. H. Stevens, who has been in the employ of the LeBlond Machine Tool Co., Cincinnati, Ohio, for some time, has been promoted to the position of machine tool foreman.

C. H. Tucker, recently of the Case Crane Co., is now in charge of the new department of the Toledo-Massillon Bridge Co., devoted to the manufacture of cranes, hoists, coal and ore-handling machinery, etc.

James Healy, for the past three years foreman of the gear-cutting department of the Stevens-Duryea Automobile Co., Chicopee Falls, Mass., has resigned and taken a similar position with the Pierce-Arrow Co., Buffalo, N. Y.

H. A. Isaacs, formerly master mechanic of the Chicago & Alton R. R. at Kansas City, Mo., and later with the Michigan R. R., has been appointed master mechanic of the Chicago & Northwestern Ry., with headquarters at Clarion, Iowa.

Charles Robbins, who for ten years has been employed in the industrial and power sales department of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., in connection with the sale of industrial motors, was recently appointed manager of this department.

George M. Vial, for the past five years in charge of the wood pattern department of the Stevens-Duryea Automobile Co., Chicopee Falls, Mass., has resigned to take charge of the wood-working department of the public manual training school of Chicopee, Mass.

Clark W. Parker, for the past three years employed by the Lamb Knitting Machine Co., Chicopee Falls, Mass., designing special automatic machinery, has resigned to become president and manager of the Parker Transmission and Appliance Co., Springfield, Mass., which is to manufacture and market one of his inventions.

S. J. Rowe, president of the Rowe Motor Co., Waynesboro, Pa., has been for the past fifteen months designing self-propelled fire apparatus for the American-La France Fire Engine Co., Elmira, N. Y. Mr. Rowe resigned his position with the company, to take effect January 1. He will hereafter devote his entire time to the business of the Rowe Motor Co.

E. P. Haight, well known in electrical circles as the treasurer of the Sprague Electric Co., was elected president of the Electric Trade Association of New York, of which Mr. Franz Neilson, 80 Wall St., is secretary. Mr. Haight's experience in the electrical trade and his energy and enthusiasm doubtless will make his administration of the society unusually successful.

Samuel A. Chase, who for the past few years was a detail and supply salesman in the New York sales office of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., recently resigned, and has taken a position with the White Investment Co., of New York, a financial investment company handling stock of many organizations. Mr. Chase will be in charge of the Chicago office of the company.

G. Brower Griffin was recently appointed manager of the sales policy of the detail and supplies sales department of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., in which department transformers, motors, switches and switch-boards, railway line material, etc., are sold. Mr. Griffin was assistant manager of the sales department for six years previous to his promotion to the position of manager, having previously been connected with the sale of detail apparatus in the Boston office.

S. Nicholson was recently appointed general sales manager of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., and has taken charge of the policy of the entire company. He has been with the company for eleven years in different capacities. He is perhaps best known to electric motor manufacturers as the organizer and president of the American Association of Motor Manufacturers, an organization which has done much in the two short years of its life to improve the art of motor manufacture.

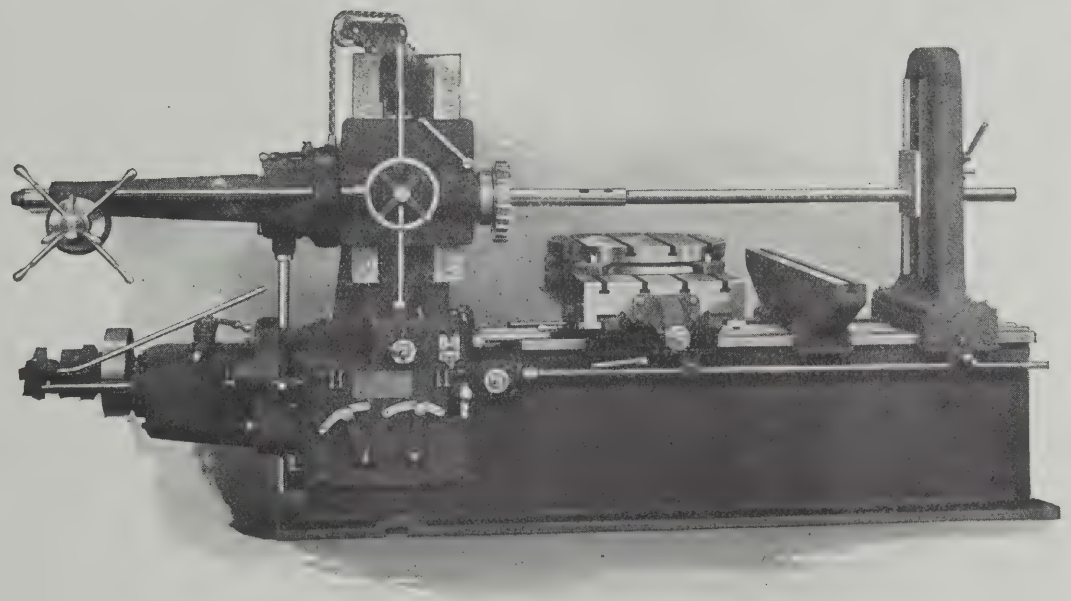
SOME gentleman with plenty of time at his disposal has figured that ONE TON OF IRON, after going through the necessary processes to make it into hair springs for watches, would be worth

TWENTY MILLION DOLLARS!

Made into almost any kind of a MACHINE it would be worth more than if made into SASH WEIGHTS.

We don't know just how much it would be worth per ton if made into a

"PRECISION"



Boring, Drilling and Milling Machine

because we don't particularly care and have never taken the time to figure it.

The DISTRIBUTION of metal concerns us more than its WEIGHT.

The metal in our machines is distributed as well as we know how to do it today, and if we can find a better way tomorrow to distribute it, WE SHALL DO IT.

Lucas Machine Tool Co., Now and always of Cleveland, O., U.S.A.

EUROPEAN AND AUSTRALIAN AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest. E. McCray & Co., Sydney, Australia.

Paul M. Chamberlain has opened an engineering office at 1522 Marquette Building, Chicago, Ill. Mr. Chamberlain was graduated from the Michigan Agricultural College in 1888 and Cornell University in 1890. For several years he was in practical work with the Brown Hoist Co., Cleveland, Ohio; Frick Co., Waynesboro, Pa.; Hercules Iron Works, Aurora, Ill. He then became assistant professor of mechanical engineering at the Michigan Agricultural College, and at the opening of the Lewis Institute at Chicago he took charge of the engineering work and brought it up to its well-known standard of excellence. Mr. Chamberlain has made a special study of boiler-room equipment, economy in fuel burning, and smoke abatement, and will devote his time principally to new designs and improvements in existing installations.

Franklin E. Snow, for twenty-nine years connected with the Wells Brothers Co., of Greenfield, Mass., and for a great part of that time its treasurer, has retired from the active management. F. O. Wells will continue as president and will also act as treasurer. Mr. Snow will be vice-president and Edward Blake, Jr., who has been sales manager for some years, has been elected a director. Mr. Snow has been one of the most prominent factors in the development and prosperity of the Wells Brothers Co., and the growth of the business from a small concern on Mill Street to the present large plant on Sanderson Street has been coincident with his connection. Mr. Snow is also interested as a stockholder in a number of other Greenfield manufacturing enterprises, to the success of which his business ability has contributed in a marked degree. In the enjoyment of a well-earned rest he will doubtless still find time to perform, in his quiet and genial way, the various duties which fall to the lot of the public spirited citizen.

Charles H. Kirchhoff, for twenty years editor-in-chief of the *Iron Age*, retired December 1. Mr. Kirchhoff graduated from the Royal School of Mines, Clausthal, Germany, and before entering journalism in 1877 he was a mining engineer and metallurgist. He worked as a chemist for the Delaware Lead Refining Co., Philadelphia, Pa., from 1874 to 1877, and during that time began contributing to the *Metallurgical Review*, and later became its assistant editor, remaining on its staff two years. Leaving the *Metallurgical Review*, he joined the staff of the *Iron Age* as assistant editor, and after two years service became editor of the *Engineering and Mining Journal*. In 1884 he returned to the *Iron Age* as associate editor, and in 1889 became its editor-in-chief. Mr. Kirchhoff is generally regarded as an authority on metallurgy and steel manufacture. He has a wide acquaintance among the steel manufacturers, and his personality undoubtedly has been a potent factor in the success and prestige of the journal that he conducted so long.

* * *

OBITUARIES

Joseph Campbell, president of the Diamond Saw and Stamping Works, Buffalo, N. Y., died November 29.

John B. Chapman, senior member of J. B. Chapman & Co., brass founders, coppersmiths, and machinists, Springfield, Mass., died at his home in that city December 6, aged fifty-five years.

F. L. Gallagher secretary and treasurer of the Modern Tool Co., Erie, Pa., died suddenly November 29, aged forty-one years. Mr. Gallagher was formerly with the Metric Metal Works, with which concern he was employed as bookkeeper until about nine years ago, when he became manager and treasurer of the Modern Tool Co. He was a man of much popularity.

Alden Sampson, 2nd, proprietor of the Alden Sampson Mfg. Co., maker of automobile and automobile trucks, Pittsfield, Mass., died at his home, December 3, aged thirty-one years. Mr. Sampson contracted a cold which developed into double pneumonia while on his homeward trip from France in the middle of November, where he had gone to observe the use of automobile trucks in army manœuvres.

Dr. Charles B. Dudley, the well-known chemist in charge of the Pennsylvania R. R. Co.'s testing work, died at Altoona, Pa., December 21, of typhoid-pneumonia, aged sixty-seven years. He held the position with the Pennsylvania R. R. Co. since his graduation from the Sheffield Scientific School in 1874. He was twice president of the American Chemical Association, and was a vice-president of the American Institute of Mining Engineers. He was also president of the American Society for Testing Materials for several years.

William Metcalf, a pioneer steel manufacturer and one of the best known metallurgists in the United States, died at his home in Pittsburg, Pa., December 7, aged seventy-one years. During the Civil War Mr. Metcalf was in charge of the Fort Pitt foundry, Pittsburg, where much of the heavy artillery used by the Northern armies was made. It was in this foundry that the Rodman cannon were cast, the Rodman process being the first effort of importance to make cannon with the internal layers in a state of compression due to cooling the core rapidly. Mr. Metcalf was head of the Braeburn Steel Co., which he organized in 1897. He was the author of several books on steel and metallurgy; his book on tool steel was for many years the only authoritative American work on the subject. In 1880 he was elected president of the American Institute of Mining Engineers, and president of the American Society of Civil Engineers in 1893. He was also vice-president of the American Society of Mechanical Engineers in 1882-1884.

* * *

COMING EVENTS

January 1-8.—Tenth international exhibit of automobiles and automobile appliances, Grand Central Palace, New York, under the auspices of the American Motor Car Manufacturing Association. R. E. Olds, chairman, 505 Fifth Ave., New York.

January 8-15.—Association of Licensed Automobile Manufacturers' tenth annual exhibition of automobiles and automobile appliances, Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 18-20.—Annual meeting of the American Society of Heating and Ventilating Engineers. W. M. Mackay, secretary, P. O. Box 1818, New York.

January 19-20.—Annual meeting of American Society of Civil Engineers, New York. Charles W. Hunt, secretary, 220 West 57th St., New York.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary. American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary. American Brass Founders' Association.

June 1-August 31, 1910.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in England.

SOCIETIES AND COLLEGES

Iron & Steel Institute, G. C. Lloyd, secretary, London, England, announces that Mr. Andrew Carnegie, past president of the association, has presented the institute with $100,000 for research scholarships. The object of this scheme of scholarships is to enable students who have passed through college or who have been trained in industrial establishments to conduct research experiments in iron and steel and related subjects. The appointment for scholarship is for one year, but the council may at its discretion renew the scholarship for a further period. Further information may be obtained from the secretary.

Massachusetts Institute of Technology, Boston, Mass., during the past year has made the requirements for the degree of Doctor of Engineering more definite, and has placed it in the hands of the board which also administers the regulations for the degree of Doctor of Philosophy. The requirements for the degree of Doctor of Engineering and Doctor of Philosophy have now been made substantially equivalent. The executive committee has voted two Austin research scholarships carrying a sum of $500 each and remission of tuition fees. These are now open to candidates for degrees of Doctor of Engineering and Doctor of Philosophy.

Museum of Safety and Sanitation, 29 West 39th St., New York, through its secretary, Dr. William H. Tolman, is giving stereopticon lectures on safety devices. A description of the work of the safety committee of the United States Steel Corporation made in Rochester so impressed the superintendent of the Rochester Railway and Lighting Co. that he organized a committee of safety in his company which employs 2,500 people. The practical results of Dr. Tolman's work are made clear by events like this which promote methods, rules and regulations for the preservation of life and limb in industrial works, railroads and other activities of life.

University of Illinois, Urbana, Ill., has recently issued a circular descriptive of its course in mining engineering lately established. The bill establishing the department of mining engineering in the state university was passed by the last state legislature. The mining and metallurgical products of the state of Illinois, for 1907, represent an output value of over $150,000,000. Although Illinois is generally regarded as an agricultural state, it has for many years occupied second place among coal producing states and the rapid development of the iron industry about Chicago has already placed the state well up among the iron and steel producing states.

CATALOGUES AND CIRCULARS

Robbins Machine Co., Worcester, Mass. Circular of Robbins 14-inch engine lathe with compound and elevating rest.

Boicourt Co., Fort Worth, Texas. Circular of Boicourt steam power pumps, deep well pumps and deep well working head.

B. C. Ames Co., Waltham, Mass. Catalogue of bench lathes and fixtures, bench milling machines and dial gages. The company builds small machinery to order.

S. A. Woods Machine Co., Boston, Mass. Circular of inside molders, a new wood-working tool in which the advantages of a molder, shaper and matcher are comprised in one machine.

Massachusetts Institute of Technology, Boston, Mass. Catalogue of the Institute giving roster of officers and instructors, courses of study, roll of students and graduates, etc.

Chicago Pneumatic Tool Co., Chicago, Ill., and New York. Circular descriptive of Franklin tandem gasoline engine driven air compressors adapted for isolated compressed power units.

Northern Engineering Works, Detroit, Mich. Booklet 24-B of Northern electric traveling cranes, hand power cranes, jib cranes, overhead trolleys, electric hoists, steel derricks, etc.

General Electric Co., Schenectady, New York. Bulletin No. 4708 on Thompson direct current test meter type CB-3, designed as part of the equipment of central power stations for periodical meter testing.

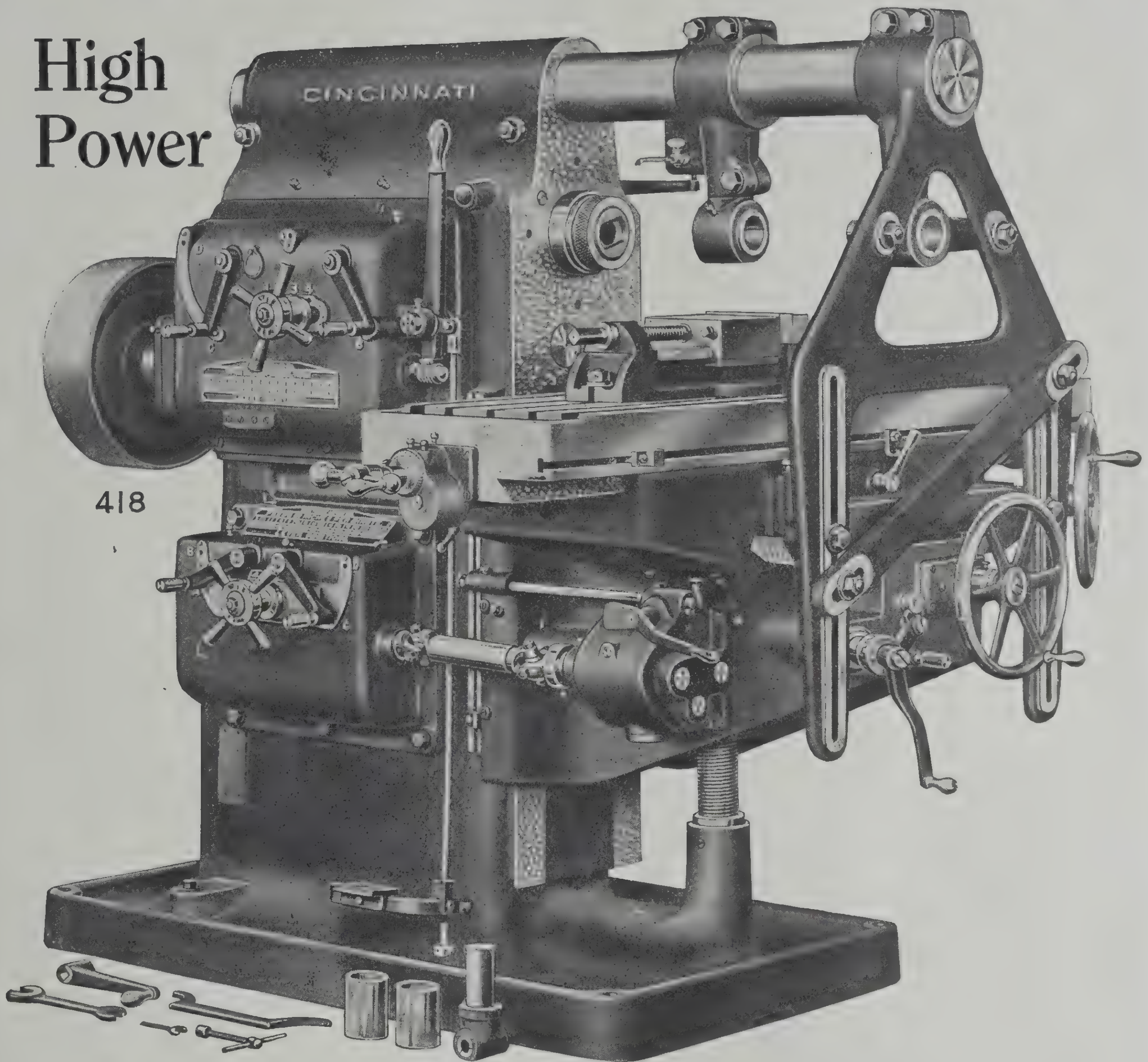
M. Rumely Co., La Porte, Ind. Pamphlet entitled "Toiling and Tilling the Soil," beautifully illustrated, advertising the Rumely "Oil Pull" tractor, a gasoline traction engine designed for plowing and hauling on farms.

Gisholt Machine Co., Madison, Wis. Leaf illustrating and describing Gisholt lathe equipment for finishing valve bodies and work of a similar nature. Also leaf illustrating Gisholt lathes used in automobile shops.

Mesta Machine Co., Pittsburg, Pa. Circular of Corliss-engine driven compressors for large capacities and pressures up to 1,000 pounds per square inch, and hoisting engines for heavy duty service and large capacities.

CINCINNATI MILLERS

High Power



THE NEWEST MILLER ON THE MARKET

All driving gears of steel with teeth of standard length and 20° pressure angle.
The drive is always through the face gear which is keyed to the spindle close against the front box.
Single plunger trip, can reverse all feeds at all times from tripped position, without interference with dogs.
Direct reading, simple, feed and speed index.
Table feed levers reverse, and also indicate direction of table travel.
Sight feed oilers on all important bearings.
Six different interchangeable drives. Change from the one in use to any other can be quickly made at any time by user in his own shop.

Ask for our 1909 catalog

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.
AUSTRALIAN AGENTS—Thos. McPherson & Son' Melbourne.

CONTENTS FOR JANUARY

American Blower Co., Detroit, Mich. Copy of recent decision of Judge Hough of the United States Circuit Court sustaining its suit against the B. F. Sturtevant Co., Boston, Mass., for infringement of patent covering Sirocco fans and blowers.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 116 on motor generator sets for air pumps; bulletin No. 117, "Motor Drive in the Laundry;" and bulletin No. 118 on form L direct current motors 1/20 to 7½ H. P. and generators 0.6 to 3½ K. W.

Arguto Oilless Bearing Co., Waynesboro, Pa. Folder advertising Arguto oilless bearings for lineshafts and countershafts in cotton mills and other locations where it is desirable to avoid the use of oil because of danger of contaminating the product.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Circular No. 1506 entitled "Recent Types of Arc Lamps and their Operation," by C. E. Stevens. The paper briefly discusses arc lamps in general, and describes the metallic flame arc lamp and its mechanism.

E. G. Smith, Columbia, Pa. Catalogue of Columbia calipers, "which-way" pocket level, Columbia spherometer, steel rules, etc. The Columbia caliper is made in various styles, one of which is provided with a vernier that makes the reading of 64ths or 128ths as easy as 16ths with the ordinary plain graduation.

American Oxyhydric Co., Milwaukee, Wis. Pamphlet on the oxyhydric process for cutting and welding metals. The apparatus and interesting examples of work done are illustrated, including clearing away the tangled steel debris resulting from a boiler explosion in the Pabst brewery, cutting 9-inch nickel-chrome armor plate, etc.

General Electric Co., Schenectady, N. Y. Bulletin No. 4705 on the Curtiss steam turbines for low pressure and mixed pressure. Various installations are illustrated, including a 5,000 K. W. low pressure Curtiss turbine generator at the 59th St. station of the Interborough Rapid Transit Co., New York.

Gould & Eberhardt, Newark, N. J. Folder entitled "The Building of a Reputation," giving a brief history of the concern and advertising the Eberhardt automatic gear-cutting machine for spur and bevel gears, automatic generating machinery for hobbing spur, worm and spiral gears, rack cutters and shapers.

Colburn Machine Tool Co., Franklin, Pa. Circular describing the Colburn floating reamer holder for use in boring mills with turret heads. (See Machinery, December, 1909.) These holders are made in two sizes, No. 1 having a No. 4 Morse taper socket and No. 2 a No. 5 socket, the maximum capacity being holes 3 and 4 inches diameter respectively.

Rockwell Furnace Co., New York. Bulletin G on annealing, hardening, and tempering furnaces fired with oil or gas fuel. These furnaces are adapted for treating, hardening, tempering, case-hardening, and annealing tools, dies, taps, punches, cutters, screws, springs: nickel, chrome, vanadium, high-speed and carbon steel; brass, copper, silver, aluminum, etc.

General Electric Co., Schenectady, N. Y., has issued an attractive pamphlet, "The Dawn of a New Era in Lighting," which treats of the history of lighting from the tallow dip to the latest development in artificial lighting, *i. e.*, the tungsten lamp. The pamphlet describes the tungsten lamp and gives figures on its efficiency, cost of operation, and describes various applications of the lamp in interior lighting. The pamphlet is No. 3885 in the series of advertising material published by the company.

Schuchardt & Schutte, 90 West St., New York. Catalogue of automatic gear hobbing machines, hob grinding machines, hob milling machinery, profile milling machines and profile grinding machines. The catalogue will be found of general interest by gear makers. It contains an illustration of the Schuchardt & Schutte factory interiors, showing the erection of hobbing machines; also views of the Melville-Macalpine spiral reducing gear built for transmitting 6,000 horsepower from steam turbines to marine propellers.

Bristol Co., Waterbury, Conn. Bulletin No. 114, illustrating and describing Bristol's recording gages for pressure and vacuum: also Bristol's recording water level gages. The practice of recording data of pressures, vacuum, water level, etc., in power plants and other places is becoming more and more prevalent as the advantages of such records are recognized. The Bristol Co. has had twenty years' practical experience in the development and manufacture of recording instruments, and offers its experience to all interested in recording such data.

Joseph T. Ryerson & Son, Chicago, Ill. Ryerson Reference Book for 1910, being a complete list of the most comprehensive stock of iron, steel, machinery, and allied specialties in the world, to which are added useful tables and information for engineers, architects, contractors, structural iron workers, etc. The reference book contains 380 pages with index, and lists beams, angles, channels, T's, Z-bars, steel separators, flanges, and tank steel parts and other steel and iron specialties, boilermakers' machinery, including the Ryerson line of internal combustion machinery (see Machinery, July, 1909). The tables and other data will be found generally valuable by users of structural shapes, plates, etc.

Cincinnati Milling Machine Co., Cincinnati, Ohio. Catalogue of horizontal milling machines (cone and single-pulley types), vertical milling machines, accessories, attachments, etc. The catalogue contains 160 pages filled with illustrated and descriptive matter. Some important improvements on the Cincinnati Nos. 1, 1½, 2 and 3 cone-driven machines are shown, especially in the column and feed mechanism. The column now used is similar to that used on the Cincinnati high-power machines, being a complete box form, containing the entire feed mechanism. The catalogue also illustrates the Cincinnati universal cutter and tool grinder which is a necessary accessory of milling machine equipment. Mechanics will find it of interest and value, if for no other reason than because of the detail illustrations throughout, and the directions contained in the chapter "Erection and Care of Millers." A full index adds to the value by making reference to descriptions of machines, accessories, etc., easy, and obviates the necessity of thumbing over the pages until the desired matter is found.

Niles-Bement-Pond Co., 111 Broadway, New York. Pamphlet entitled "Grinding—Not Milling—the Way to Machine Flat Surfaces," being an illustrated description of the Pratt & Whitney vertical surface grinder and some products. It is claimed that the Pratt & Whitney surface grinder with vertical spindle will grind from twelve to twenty times faster than ordinary surface grinders. The efficiency of the machine is partly due to the cup-shaped wheel, which covers the full width of the work while it reduces it to perfect flatness. The horizontal table facilitates chucking all ordinary work, and the magnetic chuck makes the chucking of small work very simple and rapid. Illustrations of work done comprise flat-irons aluminum castings, carbon segments, cast-iron flanges, circular saws, repeating rifle hammers and ejector levers, automatic pistol frames, knife blades, hardened steel planer knives, carpenters' planes, aluminum and iron automobile manifolds, automobile steering gear housings, automobile transmission gear cases, gear blanks, automobile cam shafts, typewriter parts, lathe chuck bodies, cast iron frames, etc. The pamphlet is a fine example of typographical work and will be found very interesting by all concerned in the economical and rapid production of surface ground work, whether they be shop managers, superintendents, foremen or machinists.

TRADE NOTES

White Co., Philadelphia, Pa., is putting a gasoline-motor driven truck of 1½ ton nominal capacity on the market.

Chicago Belting Co., Chicago, Ill., has opened a branch store at 71 Dey St., New York, with Mr. E. T. Toogood manager.

Huther Bros. Saw Manufacturing Co., Inc., Rochester, N. Y., announces that it also manufactures sheet steel specialties.

Export Corporation, Ltd., 29 Broadway, New York, wants estimates and plans of a complete plant for refining and briquetting salt.

Rae Electric Vehicle Co., Springfield, Vt., is a new enterprise which will be ready for business in January. It is erecting a new factory.

The Superior Tap Co., Springfield, Vt., has been reorganized, and will move to Charlestown, N. H., where a factory is being constructed for its use.

Bailey Automobile Co., Springfield, Mass., is making important changes in its factory and will bring out a new two-cycle motor for its 1910 cars. New machinery will be installed.

Spitzle Mfg. Co., Utica, N. Y., was recently made the sales agent of the Fulton Machine & Vise Co., Lowville, N. Y. The company will market the entire product of the Fulton Machine & Vise Co.

Standard Welding Co., Cleveland, Ohio, has recently added to its large factory a two-story building giving 50,000 square feet additional space which will be utilized by the tube welding department.

Wells Bros. Co., Greenfield, Mass., held its annual meeting of stockholders December 1 and elected the following officers: Frank O. Wells, president and treasurer; F. E. Snow, vice-president, and Messrs. Wells, Snow, White, Blake and Pratt, directors.

Air Brake Magazine, Meadville, Pa., is a new journal published by the Air Brake Magazine Co., and edited by Frank H. Dukesmith. As the name indicates, the journal is devoted to the principles, construction, action and use of steam and electric railway air brakes.

Q. M. S. Co. (Quincy-Manchester-Sargent Co.), Plainfield, N. J., has moved its Western office in Chicago from 1775 Old Colony Building to 738 First National Bank Building. The company's interests in the West will hereafter be taken care of by Mr. J. C. Hoof.

Toledo-Massillon Bridge Co., Toledo, Ohio, has recently added a new department to its business, having gone into the extensive manufacture of all kinds of cranes, hoists, coal and ore-handling machinery, etc. C. H. Tucker, recently of the Case Crane Co., is in charge of the new department.

Morrow Ball Bearing Drill Chuck Co., Elmira, N. Y., has been awarded a big contract for the machining of cast iron, steel and bronze parts used in the manufacture of automobile engines for the Overland Automobile Co. The contract will necessitate an addition to the Morrow factory and the employment of about 100 extra men.

SHOP OPERATION SHEET NO. 121

$\frac{31}{32}$	.272461	.302734	.333008	.363281	.393555	.423828	.454102	.484375
1"	.28125	.3125	.34375	.375	.40625	.4375	.46875	.5

Interpolation (continued)

Example: $\frac{3}{64} \times \frac{7}{64} = \frac{\text{next smaller area} + \text{next larger area}}{2} - \left(\frac{1}{64}\right)^2$

Both sides given in 64ths. $\begin{cases} \text{next smaller area} = \frac{1}{32} \times \frac{3}{32} = 0.002930 \\ \text{next larger area} = \frac{1}{16} \times \frac{1}{8} = \underline{0.007812} \end{cases}$

SHOP OPERATION SHEET NO. 122

SHOP OPERATION SHEET NO. 123

$\frac{7}{8}$	.027344	.054687	.082031	.109375	.136719	.164062	.191406	.21875
$\frac{29}{32}$	.028320	.056641	.084961	.113281	.141602	.169922	.198242	.226562
$\frac{15}{16}$	.029297	.058594	.087891	.117187	.146484	.175781	.205078	.234375
$\frac{31}{32}$	.030273	.060547	.090820	.121094	.151367	.181641	.211914	.242187
1"	.03125	.0625	.09375	.125	.15625	.1875	.21875	.25

The areas of intermediate rectangles varying by $\frac{1}{64}$ can be found by interpolation as the following examples show:

One side given in 64ths. $\begin{cases} \frac{3}{32} \times \frac{5}{64} = (\text{next smaller area} + \text{next larger area}) \div 2 \\ \text{next smaller area} = \frac{3}{32} \times \frac{1}{16} = 0.005859 \\ + \text{next larger area} = \frac{3}{32} \times \frac{3}{32} = \underline{0.008789} \end{cases}$

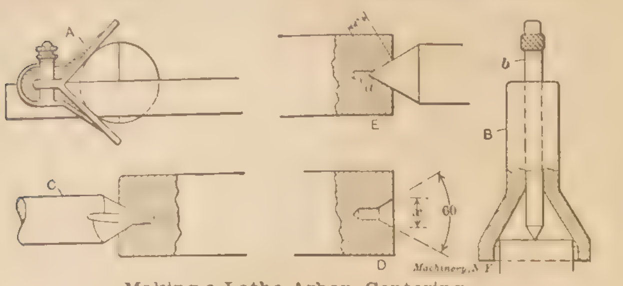
Supplement to [illegible]

s in this number entitled "T[illegible]

Operations for the Article in this number entitled "Machine Shop Practice—Centering"

SHOP OPERATION SHEET NO. 121

Franklin D. Jones MACHINERY, January, 1910



Making a Lathe Arbor—Centering

1. Select a piece of tool steel of a good grade, and cut off, in a hack-saw, a length suitable for the arbor to be made. This length will depend upon the diameter of the arbor, and it is equal to 9 times the diameter for sizes from ½ inch to 1 inch; 8 times, for sizes from 1 inch to 1½ inch, and 7 times for diameters between 1½ and 2 inches.

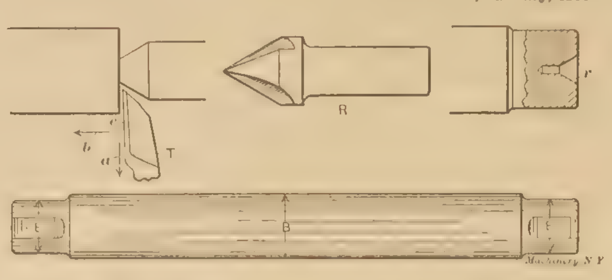
2. With a center square *A* draw two lines at right angles to each other across each end of the stock as shown, and at the intersection of these lines make a center-punch mark. If a cup or bell center-punch *B* is available, the center may be located without first drawing the lines by placing the conical part over the end of the work as shown and striking the end of punch *b*. If accurate results are expected, this punch should only be used on work which is round and square on the end. Furthermore, it should always be held in alignment with the piece being centered.

3. A combination center drill and reamer *C* is next caught in a drill chuck inserted in the spindle, or in a regular chuck of small size, and set perfectly true. A center is then drilled and reamed into one end of the work, while the other is supported by the dead center, which should be inserted in the previously made punch mark and be set in the position for straight turning. The piece may be kept from revolving while it is being reamed by attaching a dog to it close to the tail-stock end, and then adjusting the cross-slide until the dog is in contact with it. A little lard oil or other lubricant should be used when reaming. The included angle of the taper of the center, is 60 degrees (as at *D*) this being the angle to which lathe centers are ground. The size of the largest part *x* of the center, should be made equal to one-half the diameter of the arbor for sizes up to 1 inch. For larger sizes up to 5 inches in diameter dimension *x* should be made equal to (diameter — 1) ÷ 8 + 0.5. A section through a correctly formed center as it appears when in contact with a lathe center, is shown at *E*. The small hole *a*, besides being a reservoir for lubricant, provides clearance for the point of the lathe center, which should not come in contact with the mandrel, so that the latter may have a good bearing throughout the conical part *c*.

NOTE.—When a regular centering machine is available, it is not necessary to locate a center in the end of the work, as the latter is properly located with reference to the drill by the universal chuck with which the centering machine is provided.

SHOP OPERATION SHEET NO. 122

Franklin D. Jones MACHINERY, January, 1910



Making a Lathe Arbor—Turning

1. After the stock has been accurately centered, it should be carefully placed between the lathe centers. At times work is spoiled because the driving dog bears on the bottom of the driving slot in the face-plate with the result that the live center is in contact with only one side of the center in the work. Then again, chips or dirt in the centers, or the lack of oil, often results in inaccuracies which well-fitting lathe and work centers were intended to overcome.

2. The first operation performed on a cylindrical part which is being turned between the centers, is to square the ends; that is, face them so that they are flat and at right angles to the work. This is done with what is known as a right-side tool, the cutting end of which is shown at *T*. The stock should have been cut off to nearly the correct length, so that it will not be necessary to remove much metal from the ends. Usually the tool is not set so that the straight cutting edge *e* is at right angles with the axis of the work, but at a slight angle as shown. The point is then brought into contact with the work close to the center, after which the tool is fed out in the direction of the arrow *a* by the cross slide. A smooth finishing cut may be obtained by slightly rounding the tool point.

NOTE.—If the end of the work does not need to be exactly flat, the tool may be set approximately at right angles with the work axis, and then be fed in the direction of the arrow *b*, thus removing a chip equal to the width of one side. Obviously, this method is confined to comparatively small diameters.

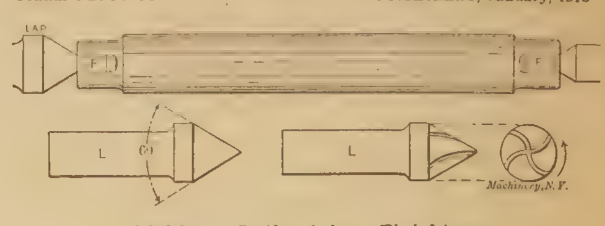
3. The arbor is first rough turned, after which it should be annealed to relieve it of any internal strains which may have been set up. The ends *E* are then finished and polished, and the body *B* is turned to size with a suitable allowance for grinding. This allowance will depend on the size and style of arbor, some being distorted in hardening more than others. An allowance of from 0.012 to 0.015 inch should be sufficient.

4. The centers are next rounded at *r* by holding one end of the arbor in a true-running chuck, while the other is supported by a steady-rest, and using a hand graver. If the corner *r* is left sharp it is easily bruised.

5. Grip a 60-degree center reamer *R* in the chuck and set it perfectly true. Then, with the spindle locked and the arbor mounted between the reamer and dead center, ream each center by hand, turning the work slowly.

SHOP OPERATION SHEET NO. 123

Franklin D. Jones MACHINERY, January, 1910



Making a Lathe Arbor—Finishing

1. The flats *F* on the ends, against which the set-screw of the driving dog is to bear, are next milled. The arbor is then ready to be hardened. This is done so that the accuracy of the centers is not easily impaired, and to give a hard surface to the arbor and make it more rigid.

2. When a piece of steel is hardened, it is usually distorted or sprung out of shape more or less; for this reason the centers in each end of the hardened arbor should be lapped true so that their axes exactly coincide. A lap *L* made of brass or copper will give excellent results. The conical ends should be finished to the same taper as the lathe center, or to an included angle of 60 degrees. All scale and dirt should be removed from the centers before lapping is begun.

3. Grip the lap in the chuck of a speed lathe (preferably) and set it perfectly true. If the tail spindle is not provided with a lever feed, remove the spindle cap so that the spindle may be easily moved back and forth. Place a little medium grade emery and oil in one center hole and with the other resting against the tail-center push the work gently against the lap which should be revolving at a high speed. Almost as soon as the lap and work are in contact, they should be separated, the work turned part way around, and again moved against the lap. After this operation is repeated a number of times, the work should be turned end for end. In this way the two centers are finally ground true and in alignment with each other. A new and perfectly true lap should be used for finishing the centers and a fine grade of emery used. As the abrasive toward the mouth of the center moves more rapidly than that farther in, and as centrifugal force tends to move it to the largest part of the hole, the lap will cut faster at this point. Because of this tendency, centers which are to be hardened and lapped are sometimes reamed to an angle (say 59 or 59½ degrees) of somewhat less than 60 degrees. Spiral grooves are sometimes cut into conical laps, which serve to carry the abrasive and oil back toward the point. In order that these grooves may be effective, they should curve toward the direction of rotation, as shown in the end view.

4. The arbor is next ground to the required size. A description of this operation will be found on sheet No. 96. After rough grinding, it is good practice to allow the work to "season" before taking the final cut.

NOTE.—The steel used for making arbors should not have too high a carbon content, as such steel is more liable to crack or spring out of shape when it is being hardened. A steel for arbors of medium size, having one per cent of carbon, will give good results.

Supplement to MACHINERY, January, 1910

Tables for the Articles in this number entitled "To Calculate the Deflection of a Special Steel Section," and "Boilers and Chimneys"

II—AREAS OF SMALL RECTANGLES

Contributed by M. Joachimson

	9/32	5/16	11/32	3/8	13/32	7/16	15/32	1/2
9/32	0.079102							
5/16	.087891	0.097656						
11/32	.096680	.107422	0.118164					
3/8	.105469	.117187	.128906	0.140625				
13/32	.114258	.126953	.139648	.152344	0.165039			
7/16	.123047	.136719	.150391	.164062	.177734	0.191406		
15/32	.131836	.146484	.161133	.175781	.190430	.205078	0.219727	
1/2	.140625	.15625	.171875	.1875	.203125	.21875	.234375	0.25
17/32	.149414	.166016	.182617	.199219	.215820	.232422	.249023	.265625
9/16	.158203	.175781	.193359	.210937	.228516	.246094	.263672	.28125
19/32	.166992	.185547	.204102	.222656	.241211	.259766	.278320	.296875
5/8	.175781	.195312	.214844	.234375	.253906	.273437	.292969	.3125
21/32	.184570	.205078	.225586	.246094	.266602	.287109	.307617	.328125
11/16	.193359	.214844	.236328	.257812	.279297	.300781	.322266	.34375
23/32	.202148	.224609	.247070	.269531	.291992	.314453	.336914	.359375
3/4	.210937	.234375	.257812	.28125	.304687	.328125	.351562	.375
25/32	[illegible]	.244141	.268555	.292969	.317383	.341797	.366211	.390625
13/16	[illegible]	.253906	.279297	.304687	.330078	.355469	.380859	.40625
27/32	.237305	.263672	.290039	.316406	.342773	.369141	.395508	.421875
7/8	[illegible]	.273437	.300781	.328125	.355469	.382812	.410156	.4375
29/32	[illegible]	.283203	.311523	.339844	.368164	.396484	.424805	.453125
15/16	.263672	.292969	.322266	.351562	.380859	.410156	.439453	.46875
31/32	.272461	.302734	.333008	.363281	.393555	.423828	.454102	.484375
1"	.28125	.3125	.34375	.375	.40625	.4375	.46875	.5

Interpolation (Continued)

Example: $\frac{3}{64} \times \frac{7}{64} = \frac{\text{next smaller area} + \text{next larger area}}{2} - (\frac{1}{64})^2$

Both sides given in 64ths. $\left\{ \begin{array}{l} \text{next smaller area} = \frac{1}{32} \times \frac{3}{32} = 0.002930 \\ \text{next larger area} = \frac{1}{16} \times \frac{1}{8} = \underline{0.007812} \end{array} \right.$

$\frac{0.010742}{2} = 0.005371$

deduct $(\frac{1}{64})^2 = \underline{0.000244}$

$\underline{\underline{0.005127}}$

I—AREAS OF SMALL RECTANGLES

Contributed by M. Joachimson

	1/32	1/16	3/32	1/8	5/32	3/16	7/32	1/4
1/32	0.000977							
1/16	.001953	0.003906						
3/32	.002930	.005859	0.008789					
1/8	.003906	.007812	.011719	0.015625				
5/32	.004883	.009766	.014648	.019531	0.024414			
3/16	.005859	.011719	.017578	.023437	.029297	0.035156		
7/32	.006836	.013672	.020508	.027344	.034180	.041016	0.047852	
1/4	.007812	.015625	.023437	.03125	.039062	.046875	.054687	0.0625
9/32	.008789	.017578	.026367	.035156	.043945	.052734	.061523	.070312
5/16	.009766	.019531	.029297	.039062	.048828	.053594	.068359	.078125
11/32	.010742	.021484	.032227	.042969	.053711	.064453	.075195	.085937
3/8	.011719	.023437	.035156	.046875	.058594	.070312	.082031	.09375
13/32	.012695	.025391	.038086	.050781	.063477	.076172	.088867	.101562
7/16	.013672	.027344	.041016	.054687	.068359	.082031	.095703	.109375
15/32	.014648	.029297	.043945	.058594	.073242	.087891	.102539	.117187
1/2	.015625	.03125	.046875	.0625	.078125	.09375	.109375	.125
17/32	.016602	.033203	.049805	.066406	.083008	.099609	.116211	.132812
9/16	.017578	.035156	.052734	.070312	.087891	.105469	.123047	.140625
19/32	.018555	.037109	.055664	.074219	.092773	.111328	.129883	.148437
5/8	.019531	.039062	.058594	.078125	.097656	.117187	.136719	.15625
21/32	.020508	.041016	.061523	.082031	.102539	.123047	.143555	.164062
11/16	.021484	.042969	.064453	.085937	.107422	.128906	.150390	.171875
23/32	.022461	.044922	.067383	.089844	.112305	.134766	.157227	.179687
3/4	.023437	.046875	.070312	.09375	.117187	.140625	.164062	.1875
25/32	.024414	.048828	.073242	.097656	.122070	.146484	.170898	.195312
13/16	.025391	.050781	.076172	.101562	.126953	.152344	.177734	.203125
27/32	.026367	.052734	.079102	.105469	.131836	.158203	.184570	.210937
7/8	.027344	.054687	.082031	.109375	.136719	.164062	.191406	.21875
29/32	.028320	.056641	.084961	.113281	.141602	.169922	.198242	.226562
15/16	.029297	.058594	.087891	.117187	.146484	.175781	.205078	.234375
31/32	.030273	.060547	.090820	.121094	.151367	.181641	.211914	.242187
1"	.03125	.0625	.09375	.125	.15625	.1875	.21875	.25

The fraction giving the altitude of the rectangle is found at top of the columns, the base in the left-hand column, and the area in the body of the table.

The areas of intermediate rectangles varying by $\frac{1}{64}$ can be found by interpolation as the following examples show:

One side given in 64ths. $\left\{ \begin{array}{l} \frac{3}{32} \times \frac{5}{64} = (\text{next smaller area} + \text{next larger area}) \div 2 \\ \text{next smaller area} = \frac{3}{32} \times \frac{1}{16} = 0.005859 \\ + \text{next larger area} = \frac{3}{32} \times \frac{3}{32} = \underline{0.008789} \end{array} \right.$

$\frac{0.014648}{2} = \underline{0.007324}$

(Continued on Sheet No. 2.)

IV—CHIMNEY DIMENSIONS FOR CORNISH, LANCASHIRE AND TUBULAR BOILERS

Contributed by A. Wind

Type of Boilers		Cornish					Lancashire							Tubular Boilers										
Diameter of Boiler		46"	50"	54"	60"	66"	[illegible]	66"	70"	76"	80"	86"	90"	50"	56"	60"	66"	70"	76"	80"	86"	90"	96"	10"
Grate Area Per Boiler, Square Feet		10	14	15	16	21	22	26	30	36	39	44	47	10	14	16.5	21	30	34	38	39	43	46	49
Chimney Height, Feet	Chimney Diam. Feet Inches	Number of Boilers to One Chimney																						
40	2' 0"	1	1	1										1	1	1								
45	2' 3"	2												2										
50	2' 6"		2		1		1								2		1							
55	2' 9"	3		2				1						3		2								
60	3' 0"	5	3			1			1	1				5	3			1	1					
65	3' 3"			3	2		2				1	1				3	2			1	1	1		
70	3' 6"		4					2					1		4								1	
75	3' 9"			4												4								1
80	4' 0"		5		3	2	3		2						5		3	2						
85	4' 3"			5				3		2						5			2					
90	4' 6"				4	3	4		3		2					6	4	3		2	2			
95	4' 9"				5		5	4				2					5					2	2	
100	5' 0"					4	6		4	3	3		2				6	4	3	3	3			2
105	5' 3"						7	5									7							
110	5' 6"					5	8	6	5	4		3					8	5	4			3		
115	5' 9"						9	7			4		3							4	4		3	
120	6' 0"						10	8	6	5		4						6	5			4		3
125	6' 3"							9	7		5		4					7		5	5		4	
130	6' 6"							10	8	6		5						8	6			5		4
135	6' 9"								9	7	6		5						7	6	6		5	
140	7' 0"								10		7	6							8	7	7	6		5
145	7' 3"									8			6										6	
150	7' 6"								12	9	8	7								8	8	7		6
155	7' 9"									10	9	8	7							9	9	8	7	
160	8' 0"										10		8							10	10	9	8	7
165	8' 3"									12		9												8
170	8' 6"										12	10	9									10	9	
175	8' 9"												10										10	9
180	9' 0"											12												10
185	9' 3"										15		12											
190	9' 6"											14												
195	9' 9"											15												
200	10' 0"												15											

III—AREAS OF SMALL RECTANGLES

Contributed by M. Joachimson

	17/32	9/16	19/32	5/8	21/32	11/16	23/32	3/4
17/32	0.282227							
9/16	.298828	0.316406						
19/32	.315430	.333984	0.352539					
5/8	.332031	.351562	.371094	0.390625				
21/32	.348633	.369141	.389648	.410156	0.430664			
11/16	.365234	.386719	.408203	.429687	.451172	0.472656		
23/32	.381836	.404297	.426758	.449219	.471680	.494141	0.516601	
3/4	.398437	.421875	.445312	.46875	.492187	.515625	.539062	0.5625
25/32	.415039	.439453	.463867	.488281	.512695	.537110	.561523	.585937
13/16	.431641	.457031	.482422	.507812	.533203	.558594	.583984	.609375
27/32	.448242	.474609	.500976	.527344	.553711	.580078	.606445	.632812
7/8	.464844	.492187	.519531	.546875	.574219	.601562	.628906	.65625
29/32	.481445	.509766	.538086	.566406	.594727	.623047	.651367	.679687
15/16	.498047	.527344	.556641	.585937	.615234	.644531	.673828	.703125
31/32	.514648	.544922	.575195	.605469	.635742	.666016	.696289	.726562
1	.53125	.5625	.59375	.625	.65625	.6875	.71875	.75

	25/32	13/16	27/32	7/8	29/32	15/16	31/32	1
25/32	0.610352							
13/16	.634766	0.660156						
27/32	.659180	.685547	0.711914					
7/8	.683594	.710937	.738281	0.765625				
29/32	.708008	.736328	.764648	.792969	0.821289			
15/16	.732422	.761719	.791016	.820312	.849609	0.878906		
31/32	.756836	.787109	.817383	.847656	.877930	.908203	0.938477	
1	.78125	.8125	.84375	.875	.90625	.9375	.96875	1.00000

Areas of rectangles larger than given in table:

Example: $\overset{a}{1}\overset{b}{\tfrac{11}{16}} \times \overset{c}{2}\overset{d}{\tfrac{3}{32}} = a \times c + b \times c + a \times d + b \times d$

$a \times c = 1 \times 2 = 2.000000$

$b \times c = \frac{11}{16} \times 2 = 1.375000$

$a \times d = 1 \times \frac{3}{32} = 0.093750$

$b \times d = \frac{11}{16} \times \frac{3}{32} = \underline{0.064453}$

$\underline{3.533203}$

MACHINERY

Railway Edition for Locomotive Construction and Repair Shops

February, 1910

LOCOMOTIVE BUILDING AT ALTOONA*

MAKING MAIN AND SIDE RODS AT THE JUNIATA SHOPS

RALPH E. FLANDERS†

THERE are some of us, even among those who have considerable traveling to do, who never get over our childhood's love of "riding on the cars." Such of us as are commuters may, perhaps, become hardened to the pleasures of their twice-a-day journey between home and work; but any break in this routine, even though over roads reasonably familiar, is looked forward to with anticipation. There is always something of interest to be seen in the endless panorama which flies past the car windows; there is always new knowledge to be gained of the geography of the country traversed; there is always something of interest to be noted in the management of the road itself—in the rolling stock, the motive power, the road-bed and the personnel; and there seldom fails to be something in the way of human interest to be found among one's fellow passengers, exciting curiosity or amusement or exasperation, as the occasion requires.

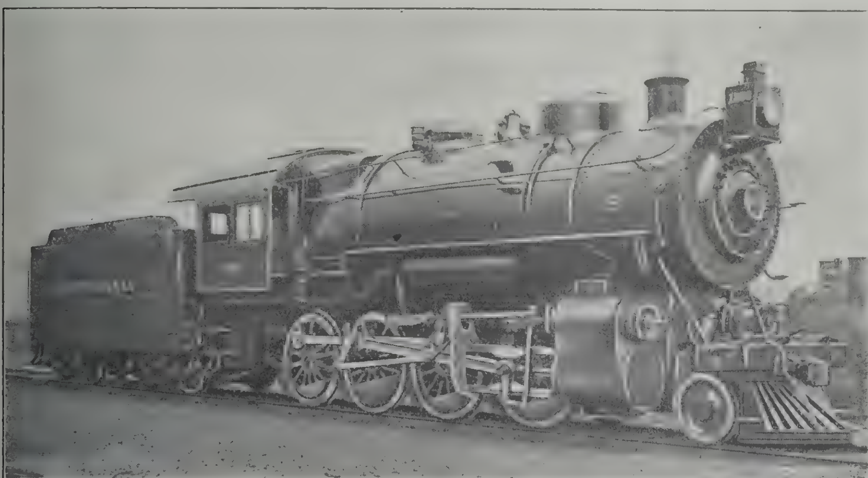


Fig. 1. Type H-8-B Consolidation Freight Locomotive built for the Pennsylvania Railroad at the Juniata Shops, Altoona, Pa.

The wide western plains, the spectacular engineering work in the Rockies and the Sierras, the gorgeous coloring of the arid desert regions, all add interest to travel in the newer parts of the country. In spite of these more widely advertised features, however, the favorite railroad trip of the writer is one that lies in the heart of one of the most populous and busiest sections of the country—that over the main line of the Pennsylvania Railroad from New York to Pittsburg. Perhaps the comfort of traveling on this line has something to do with its attractiveness. Most of us are amenable to the charms of comfortable cars, smooth road bed, courteous service and fast running trains; but the country itself, as seen from the windows on this journey, is a veritable epitome of the beauties of nature and the latest advances in the progress of civilization.

The first stretch of the journey between Jersey City and Philadelphia is a familiar one, with its long line of billboards on either side, broken by occasional suburban towns and manufacturing cities. The most interesting thing on this stretch is the traffic itself, and the way in which it is handled. This division is a veritable race-course, and a crowded one at that; four tracks, sometimes six, and all of them filled with traffic. Train after train is met, slow freight, fast freight, accommodation and express—the latter drawn by locomotives which fit to a T, Kipling's characterization of "running like a scared cat on top of a back-yard fence." Perhaps the most complicated and responsible job of train despatching in the world, is that of taking care of this traffic between Jersey City and Philadelphia. Trains are shuttled from track to track as need requires. The fast freights pass the slow freights, the locals pass the fast freights, and the expresses pass them all.

From Philadelphia to Harrisburg the road lies through what must surely be the richest farming land in the country. There are no very large cities, but instead a succession of country towns, many of them with quaint names like "Bird-in-Hand" and "Highspire." This country is populated largely by Quakers. If you are riding through on a Sunday, you will see them going to or from church. The vehicle used is a long-bodied wagon with a covered top. On the front seat sits father and the oldest boy, with perhaps one of the youngsters.

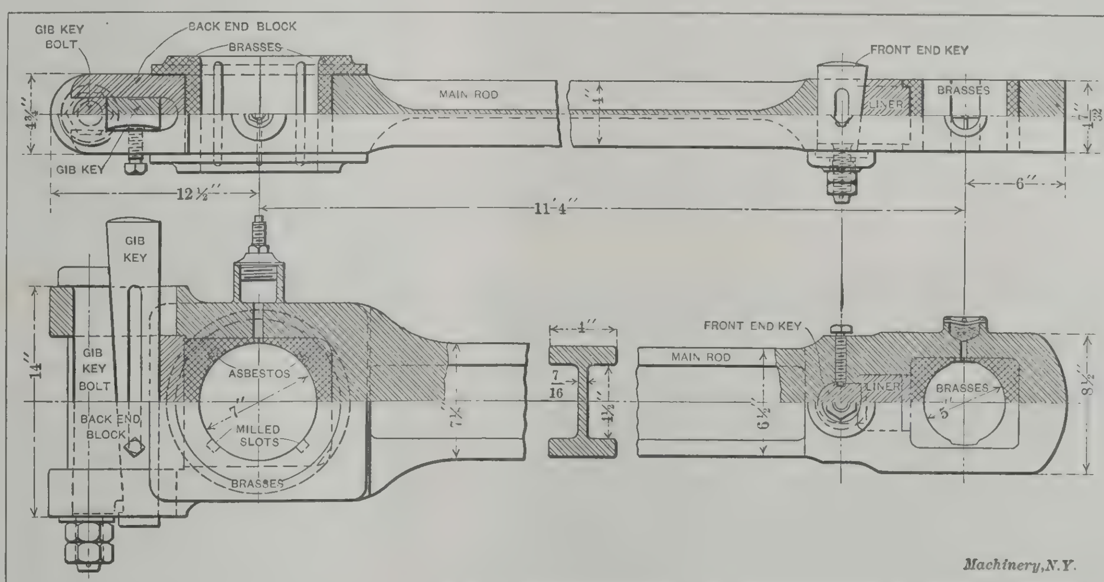


Fig. 2. Details of New Design of Connecting-rod or Main-rod used on Pennsylvania Consolidation Locomotive

* For previous articles on the Juniata shops see RAILWAY MACHINERY, November and December, 1901, and January, 1902.

† Associate Editor of MACHINERY.

In the cavernous recess at the rear, you can catch a glimpse, if you are quick enough, of a woman's face under a drab Quaker bonnet; and the chances are that there are two or three more children stowed away in there also. The wagon is usually drawn by a single, stout and comfortable horse. The whole countryside reflects the Quaker characteristics—prosperous, well-kept, neat and friendly. The houses are largely of stone or brick, the outbuildings and fences are all whitewashed, and every foot of arable land has been brought under cultivation.

From Harrisburg to Altoona we have a 130-mile stretch of river scenery, the first part of it along the Susquehanna (crossed by the magnificent 3,800-foot, 48-arch, stone masonry bridge), and the rest of the way along the Juniata, a tributary stream. The valley of the latter is for the most part very narrow and hemmed in by high mountain ridges. The track is crooked, and the flying train barely misses the corners of the projecting ledges as it swings around them; but the curves are easy and the track is smooth and the train scarcely slackens in its speed; but we are climbing all the time, as is evidenced by the endless miles of riffle in the stream. Narrow valleys open out to the right and the left, some of them bringing down branch lines from quarries and mines, and up these valleys glimpses can be caught of still higher mountains. Finally, at Altoona, the valley opens out into a wide plateau

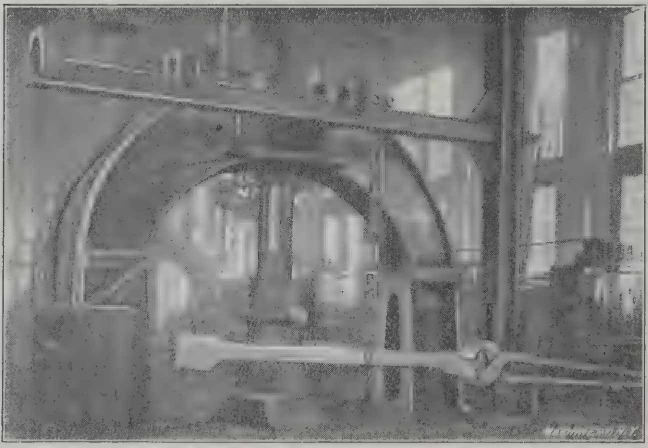


Fig. 3. Finishing the Main Rod Forging under the Steam Hammer

lying at the foot of the main ridge of the Alleghany Mountains. Here the real climb commences. The single engine which has drawn the train from Harrisburg is taken off and two fresh ones are attached; and sometimes, on a heavy train, a third one is added.

There is no stretch of track in the world equal in interest to the twelve mile climb from Altoona, around the Horseshoe Curve, to the summit tunnels at Galitzin. Out in the Rockies they will show you twists and hairpin curves, turns and loops,

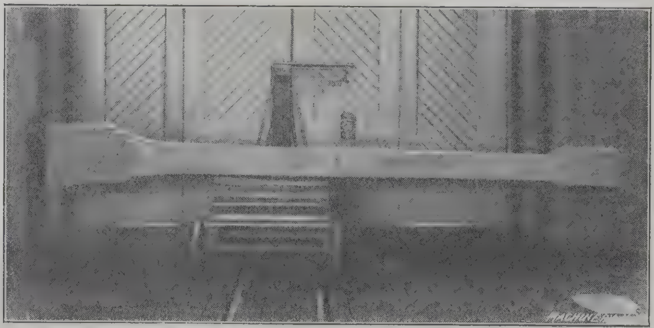


Fig. 4. Weight of the Rough Main Rod Forging

until the head is dizzy; the Canadian Pacific and the railways of the Alps have corkscrew tunnels and other contrivances for surmounting the rock barriers placed across the stream of commerce. But many of these engineering feats are performed for roads carrying, at the most, two or three trains a day, often on narrow-gage tracks at that. Here we have a four-track, standard-gage trunk line, of one of the two largest railroad systems in the country, whose traffic is concentrated here as at the throat of an hour-glass.

The Alleghanies form a tremendous handicap to the Pennsylvania system, but the problem has been bravely tackled. The road climbs out of Altoona along the southern slope of the ridge to the westward of the town, bending into the ravines and out around the points of the ridges, and climbing all the time. At a narrowing of the valley formed between this ridge and the next one to the south, the road abruptly crosses and turns back on its track, heading for the east again. This is the famous Horseshoe Curve. Still laboring upward, it rounds the point of this second ridge and returns to its westward direction, clinging to a shelf far up the side of the mountain, a thousand feet above the floor of the valley which it left only ten miles back.

Fig. 5. Double-head Planer for Surfacing the Main Rod Ends

The view from the little station at Allegrippus is a marvelous one. Countless mountain summits stretch away to the east and south, melting into the faint blue haze which perpetually hangs over this region. Distant trails of smoke and steam, and long gashes cut in the rock faces of the ledges, mark the existence of other tracks than those we have been ascending, and give evidence of the indomitable energy of man in surmounting the barriers thrown up by Nature, and in gaining for himself the riches she has hidden away. From now on, almost every valley leading off to the right or the left has its line of track running off into the mountains, and bringing back its cargoes of coal and coke. But this view from Allegrippus, though inspiring, is a short one. The train soon plunges into the Galitzin tunnel, and the climb is over.

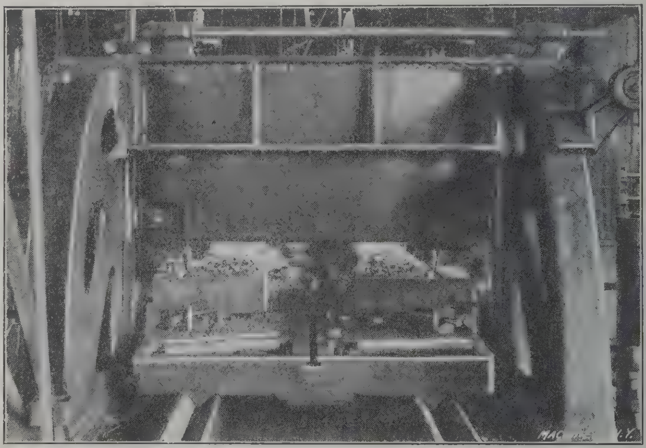


Fig. 6. Rear View of Planer showing Four Tools at Work on One End of Two Main Rods

The long grade down into Pittsburg is, perhaps, as interesting in the evening as when seen by daylight. There is not quite the display of flame and flame-lit smoke that could be seen in former days, before the waste gases of the furnaces were captured for heating the blast and firing the boilers; but the old bee-hive coke-ovens are still in use, and hundreds of them are seen from the track, their sultry red fires momentar-

ily breaking the gloom, and giving a diabolic tinge to the shadowy figures of their attendants. After leaving behind the ramshackle rattle of the Johnstown rolling mills, the country becomes more and more thickly populated. Town joins to town, and in the last few miles before entering Pittsburg, the succession of manufacturing plants, tenement houses and freight yards is unbroken. Pittsburg is certainly the "manu-

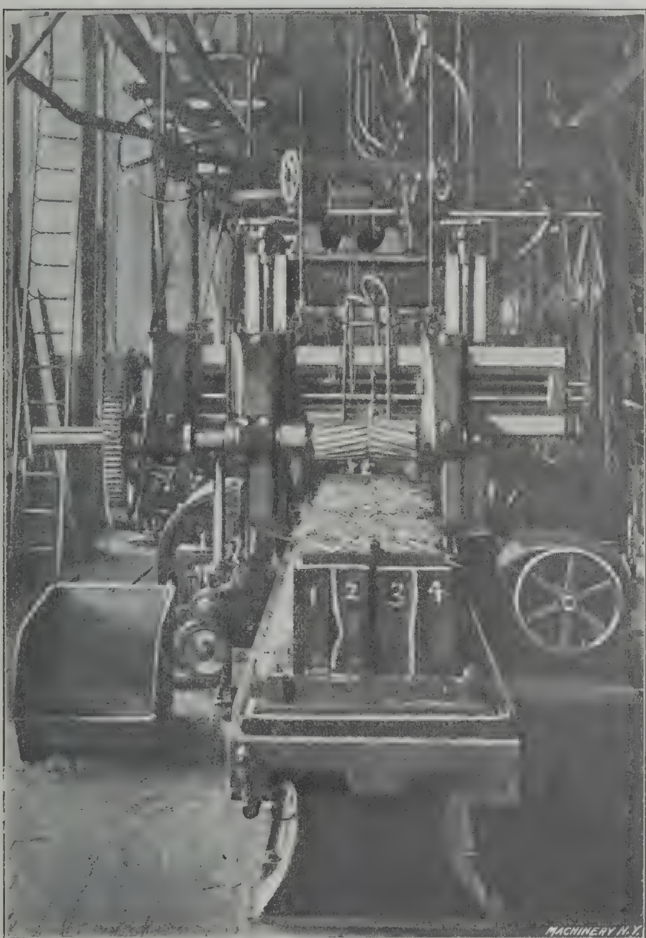


Fig. 7. Finishing the Top and Bottom Edges of the Main Rods in the Slab Milling Machine

facturingest" city in the world, but—glory be!—you can get a train out at almost any hour of the day or night.

Altoona

Altoona is the focus of railway activity in this mountain region. It forms the terminal of the Eastern and Western Pennsylvania Divisions, and there is scarcely a moment of the day when trains are not arriving or departing. The density of the traffic is best realized, perhaps, by sitting on the slope of the mountain-side above the Horseshoe Curve (as the writer did one Sunday afternoon) and watching the trains slowly panting upward or carefully sliding down the heavy

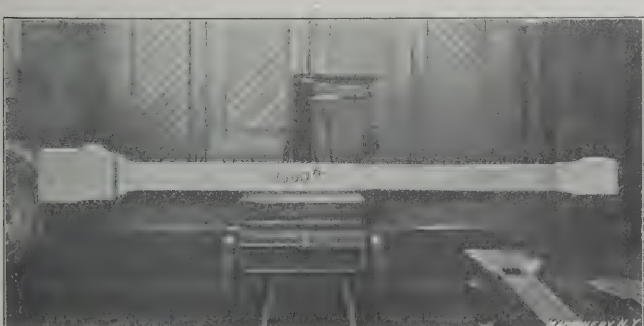


Fig. 8. The Main Rod Roughed Out

grade. Apparently there is not an hour of the twenty-four, when one or more trains are not visible from this point. The sound of laboring locomotives and clanking couplings ceases not by day or night, year in or year out.

Aside from its importance as a division terminal, the town is still further distinguished by being the location of an immense system of railroad shops. It has, in fact, probably the largest railroad population in the world, numbering about seventy thousand inhabitants. The only other business of any size in the place employs not over one thousand workmen. All the miscellaneous industrial activities, such as those of the storekeepers, doctors, street-car employes, policemen, preachers, etc., must be credited to the railroad, as they serve the railroad employes, and without them they would be out of work. The Pennsylvania Co. has here an immense locomotive repair shop, a locomotive testing plant, car shops, and foundry; and a locomotive building plant at Juniata, a suburb toward the east. It was this latter shop in which the writer was particularly interested.

Shop Practice from the Juniata Plant

Here are built all the passenger engines for the Pennsylvania Railroad, and many of the freight engines as well. It takes a system the size of the Pennsylvania to build locomotives in sufficient quantities to make a shop of this kind profitable or possible. As it is, the types have been standardized and the work has been brought down to a manufacturing basis. The extent to which the interchangeable idea has been

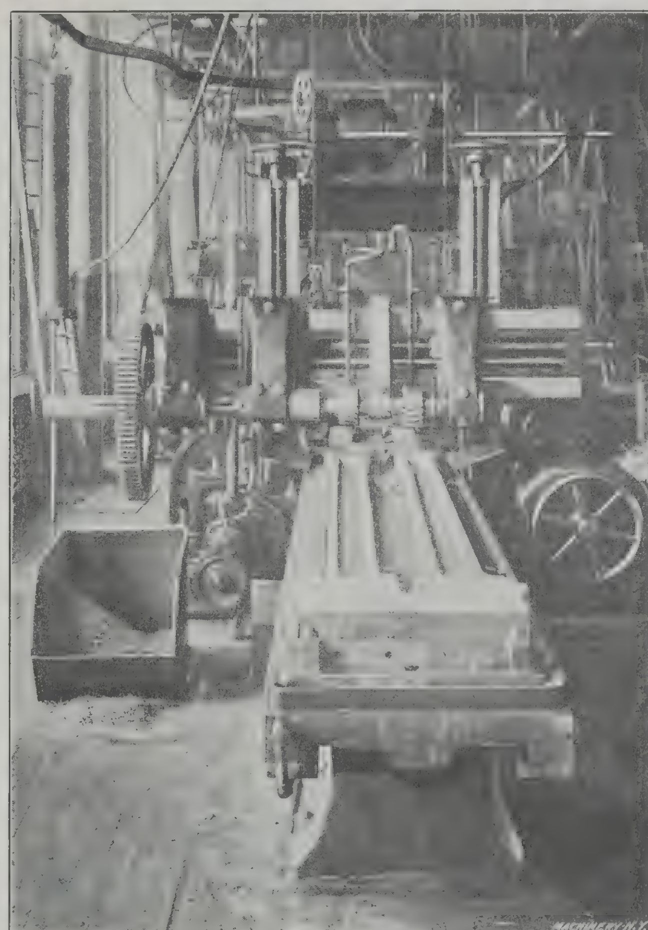


Fig. 9. Channeling Operation performed with Inserted Tooth Cutter

carried out would seem incredible to a mechanic not familiar with locomotive building, or familiar only with old-fashioned practice in that work. The visit was an enlightening one in this particular to the writer. Perhaps something more on this line can be said later on. On this visit he was interested particularly in getting photographs and material for describing in detail the manufacture of a particular part or a series of parts of the locomotive. For this the main and side rods were selected. The separate operations are comparatively simple and may be shown readily by photographs. Many of them are ingenious, however, and some of them have highly suggestive value for similar work in other lines. The whole series presents a record of shop practice of which the plant has no reason to feel ashamed.

The rods chosen for illustration are those for a heavy consolidation freight locomotive. A drawing of the main rod is shown in Fig. 2. It will be seen to differ radically in some particulars from the standard design. While the cross-head end is of familiar construction, the rear end catches the eye

at once in looking at the finished locomotive. This is due to the placing of the key at the outside end of the rod. A rod made like this has an unfamiliar appearance, but its advantages grow on the beholder as he looks at it.

The construction is exceedingly simple, requires considerably less machining and a much smaller number of bolts and other small parts. It would seem to be secure as well. It will be noted that the key has a projecting lip at its lower end, which interlocks with a notch cut in the lower end of the bolt. This, in connection with the lock nuts on the bolt and the groove provided for the point of the set-screw in the key, makes it practically impossible for anything to get loose and fly out. To have this happen, the key set-screw would have to be unscrewed, or the point broken off; the cotter pin for the lock nuts on the bolt would have to be sheared; both nuts would have to be loosened and fall entirely off; and then both bolt and key would have to be thrown out at the top of the opening. It will be noted that the channeling is parallel. This permits the operation of cutting it out to be performed at one setting for each side. The flanges of the section are thickened at the rear end, giving the necessary increase in strength.

Roughing Operations on the Main Rod

Fig. 3 shows the blank for the main or connecting-rod in the forge shop. This article deals with the machining operations particularly, so the forging will not be elaborated on. The picture is interesting, however, in showing the type of equipment provided in this plant. Attention should be called to the large, airy room and the fine lighting. The completed forging is shown in Fig. 4 mounted on the scales. The weight

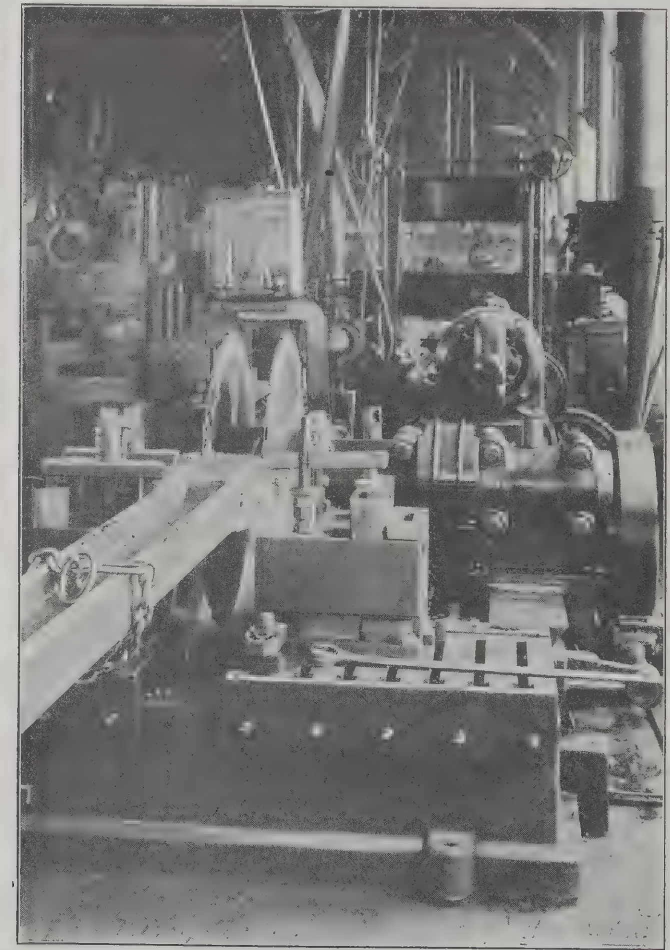


Fig. 10. Cutting out the Jaws for the Open End of the Rod in a Double-blade Sawing Machine

of the particular one shown was 1,985 pounds. This should be noted, as later on figures will be given to show the amount of metal removed in the different machining operations. It may be mentioned that the main rods, and all other parts of the locomotive, for that matter, look very much larger on the floor of the shop than they do when seen in place on the finished machine as it stands on the track. This ton-weight of forged steel is a very imposing piece of metal, indeed.

The first shop operation is that of planing the sides, top and bottom of the two heads of the main rod. The sides in this operation are planed down to size, while the top and bottom are roughed only, these surfaces being of complicated form as may be seen from Fig. 2.

These cuts are taken on a planer of special design, widely

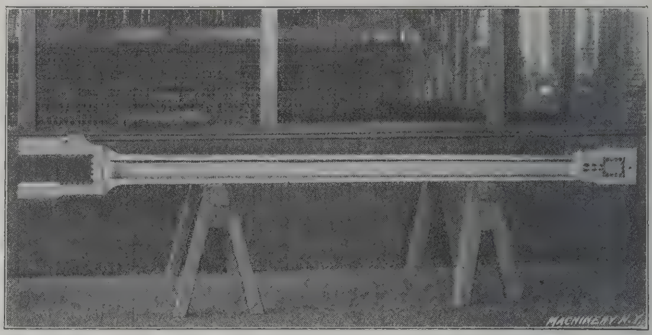


Fig. 11. The Main Rod ready for the Slotting Operations

used for this work. As best seen in Fig. 5, it has two sets of housings and cross-rails. Each set is provided with two tool heads on the cross-rail and two side heads, making eight tools available for simultaneous working. In the case

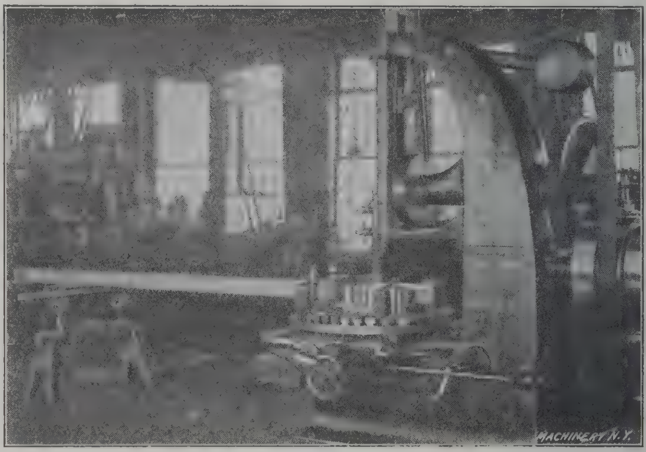


Fig. 12. Finishing the Open End on the Slotting Machine

shown all eight tools are at work. The table of this machine is not provided with a quick return, since the tools on one end cut in one direction, while the others cut on the back stroke. The housings at the right of Fig. 5 are adjustable along the length of the bed to agree with the length of rod being machined, thus adapting them for intermediate and end rods as well as for the long connecting-rods here shown. Fig. 6 shows a rear view from one end of the machine, showing four of the tools at work. The four at the other end are set in similar positions.

After machining one face and one edge at each end, as shown in Fig. 6, the rods are turned over onto these machined surfaces to permit the finishing of the other face and other edge of each. The methods of holding the work are of the simplest, being those used in standard planer practice. The rough planing of these surfaces leaves the rods in a condition to be clamped to the table and to each other on machined surfaces for subsequent operations.

Laying Out and Finishing the Body of the Rod

The rods are now taken from the planer and placed on horses in the open floor, where a workman lays the templet on each of them and scribes around it, on the planed faces of the two heads, the outline to which the rod is to be finished. On these lines he prick punches the centers for the various drilling operations required in working out the open and closed ends of the rod, and in machining the slots for the keys, bolts, etc. The laying out for all subsequent operations is all done at this time. By scribing from a templet in this way, assurance is given that the forging will finish out to the required size, and the work of taking measurements in machining is greatly reduced.

Fig. 7 shows the next machining operation, which is that of milling the top and bottom of the I-beam section of the rods. This is done, as shown, in a heavy slab milling machine with inserted tooth cutters, of which we will have

more to say later. Four of the forgings are mounted in place on the machine at a time. The ends of each rod are blocked up to bring the surface to be milled horizontal and at the proper height, as indicated by the scribed outline on the work.

It will be noted that piece No. 2 shows evidence of having got into difficulties. The distortion shown, however, is evidence of remedial action, instead of being the original cause of the trouble. The workman found, in lining this piece up

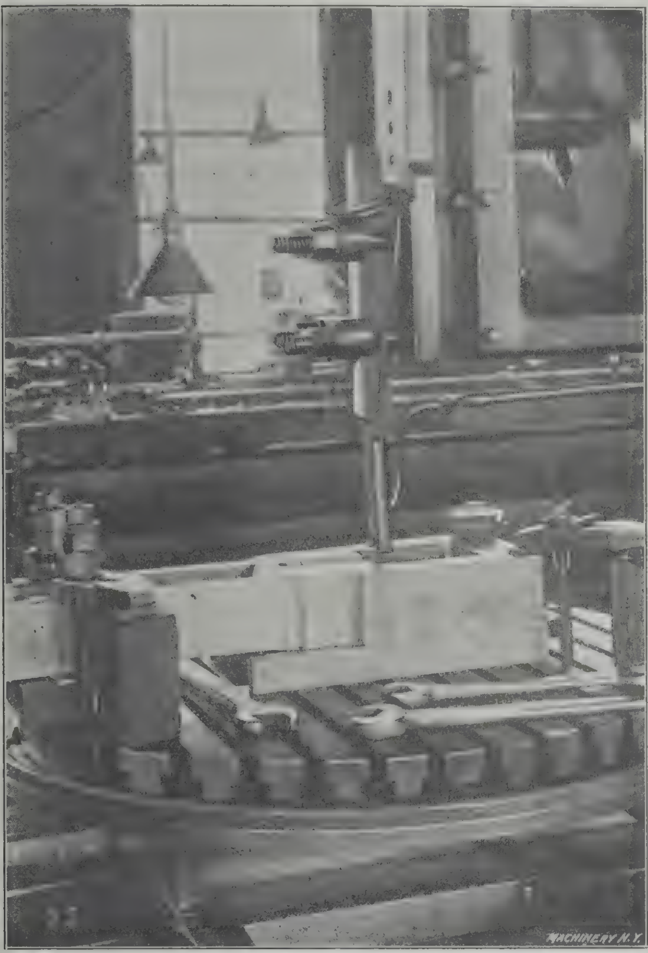


Fig. 13. Working out the Openings at the Cross-head Ends of the Main Rod

on the planer in Fig. 5, that there was not stock enough to finish out the open end of the rod to the full width. It was, therefore, sent back to the shop and swaged out in the center, as shown, which widened it to the required dimensions. The reduced portion in the center comes in the part which is cut out to receive the brasses, so that it still permits the head to be finished out to the required dimensions. The kind and amount of chips produced in this operation give evidence of

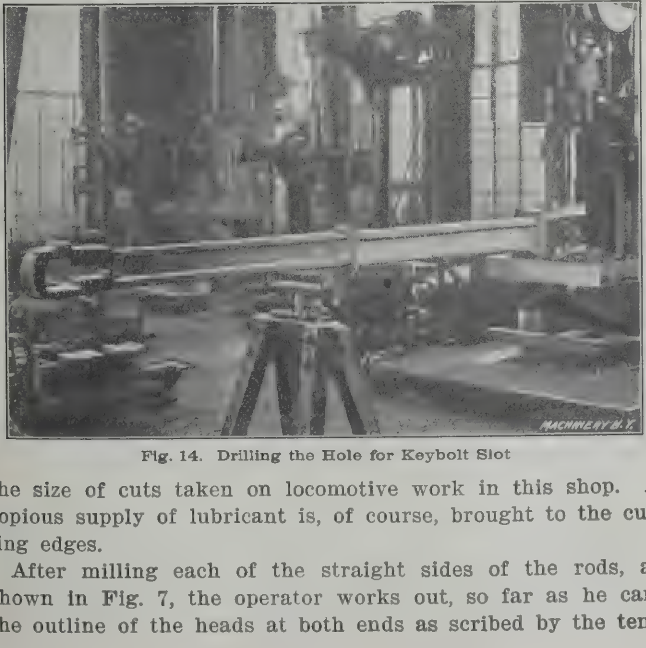


Fig. 14. Drilling the Hole for Keybolt Slot

the size of cuts taken on locomotive work in this shop. A copious supply of lubricant is, of course, brought to the cutting edges.

After milling each of the straight sides of the rods, as shown in Fig. 7, the operator works out, so far as he can, the outline of the heads at both ends as scribed by the templet. This is done by raising or lowering the cross-rails by hand as the table is fed past under the cutters, following the scribed line and working out the metal close to it. This operation naturally requires considerable skill on the part of the operator in following the line as closely as possible without breaking through it. The result of his skill is shown in Fig. 8, where the forging, as it looks after this operation, is shown on the scales. It will be noted by comparing this with Fig. 4 that 485 pounds of metal have been removed so far.

The I-beam section has next to be formed in the body of the rods by the milling of channels on each side. This operation is shown in progress in Fig. 9. The same machine is used as shown in Fig. 7, using inserted tooth cutters of the proper dimensions with corners rounded to the radius of the inside edges of the channel. Two rods are laid on the table side by side, held by suitable stops and clamps. The cutters for this operation are 8¾ inches in diameter, and they revolve at 36 revolutions per minute, giving a surface speed of 82 feet per minute. The table feed is 1⅝ inch per minute. Two cuts are taken over each channel to bring it down to depth, the cut being 4½ inches wide and about ⅞ inch deep for each cut and cutter.

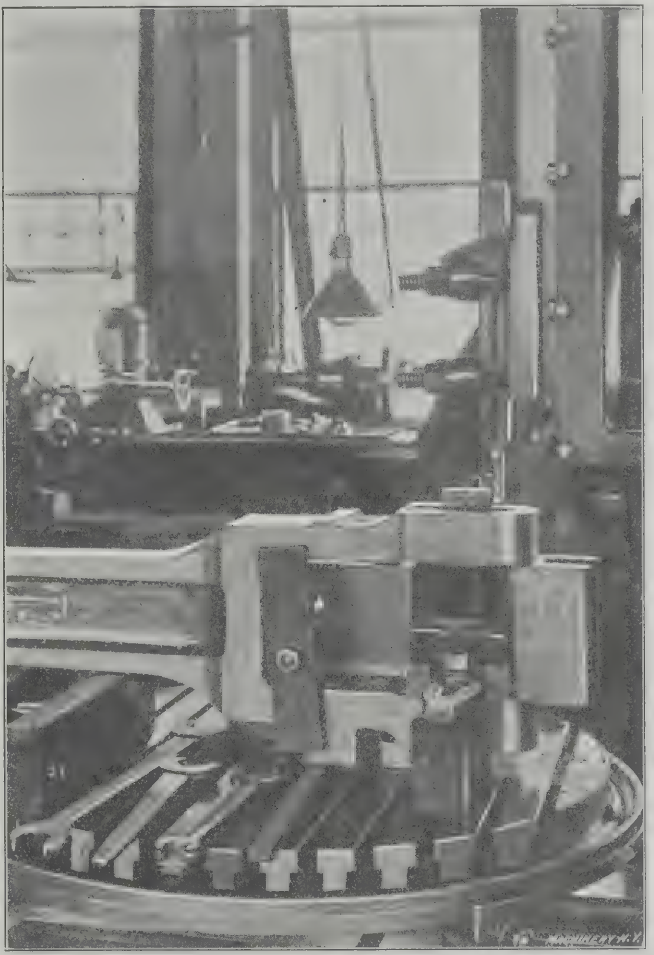


Fig. 15. Working out the Keybolt Slot on the Slotting Machine

The supplementary support for the cutter arbor between the two cutters was no part of the original equipment, being added in the shop. It was found to greatly increase the capacity of the machine. It is only in the past decade that mechanics have discovered how important in the matter of production, is a support for the tools and the work rigid enough to prevent the harmful vibration and chattering, which destroys the edges of cutting tools. The amount of metal removed in the operation shown in Fig. 9 is something over 500 pounds for each rod. At 1⅝ inch feed per minute, this figures out to a very lively cutting time, for cuts as narrow as these are.

Working Out the Jaws, Key-slots, etc., of the Main Rod

The rods are now taken to the drill press to drill the holes mentioned in the operation of laying out the work with a templet. For the rear or large end of the connecting-rod, the block taken out in forming the jaws is not removed en-

tirely by drilling. As shown in Fig. 10, this block is cut out by a double sawing machine, the drill holes being used beyond the extreme depth to which the saws can enter. The outer end of the rod is supported on a horse in this operation, remaining stationary, since the feed is applied to the head on which the saw is mounted. These saws are of the inserted tooth type.

Fig. 11 shows the condition of the rod at the end of the operation shown in Fig. 10. It also shows the various holes drilled from the lay-out provided by the templet. It will be noted that holes of various diameters are used. At the large end the large holes at the bottom of the jaws are properly located and of the proper diameter to furnish the radius surface to which the inner corners of the opening are finished. In the same way the corner holes of the opening at the small end and the large holes in the key-slot are properly located and sized for finishing at these points. This accuracy in the

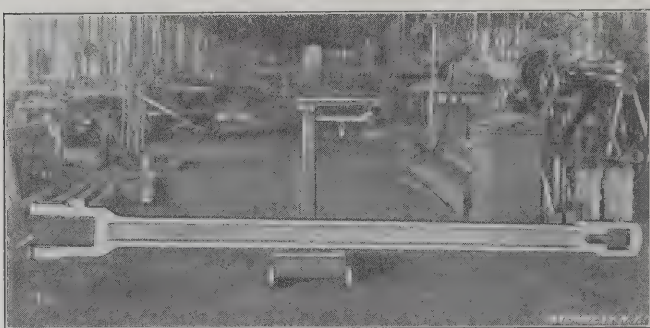


Fig. 16. The Main Rod at the Completion of the Machine Work

laying out and drilling of these holes simplifies the finishing operations in the slotting machine very greatly.

Fig. 12 shows the slotter at work on the rear end of the rod. A tool is used having cutting edges rounded to the radius of the corners of the opening, so as to join easily onto the radius produced by the drill holes. Comparatively simple outlines are required, as is shown plainly in Fig. 2. The lines scribed by the templet furnish the guide to the operator in this operation. The same cuts for the small end of the rod are shown in progress in Fig. 13, which more plainly shows the form of tool used. This is provided with top rake

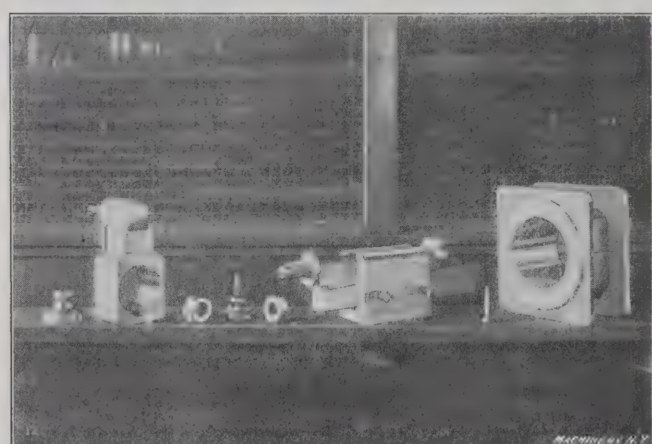


Fig. 17. The Brasses, Liners, Gibs, Bolts, etc., to be fitted into the Main Rod

as shown, and will cut when feeding in all four directions. A rubber tube for the lubricant is brought down close to the cutting point.

Fig. 12 and, later on, Figs. 25 and 31, show an interesting form of cutter support for heavy over-hanging work of this kind clamped to the slotting machine table. A horse or trestle is provided with a pair of leveling screws, each supporting a roller. On these rollers, as shown, is mounted a bar provided, in turn, with pivots for a second long roller. On this the work rests. It will be seen that this arrangement allows the work-table of the slotting machine to be fed or adjusted in and out, or from one side to the other, without any interference to this movement from the support of the outer end. The work will roll freely in and out on the long upper roller, and the bar on which that roller is mounted will roll freely from side to side on the revolving screws, supported by the trestle.

After finishing out the openings as just described, the rod is taken to the drill press, where the holes for the two ends of the key-slot are drilled, as shown in Fig. 14. Fig. 15 shows this slot being worked out with a tool similar to that shown in Fig. 13. A key-block, such as is used in the finished rod,

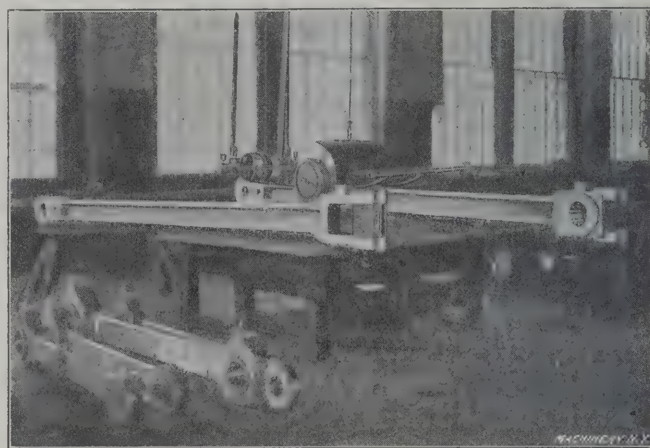


Fig. 18. Suspended Emery Grinder used for Finishing

is mounted between the two ends of the jaws, as shown, to take the strain of the cutting and the clamping in place so as not to spring the work. The outer end is supported as in Fig. 12.

In the next operation the oil holes are drilled and counterbored and the oil cup at the small end is worked out. This is rounded, as shown in Fig. 2. The oil cup at the large end is not rounded at the present time, as it is shown, being left

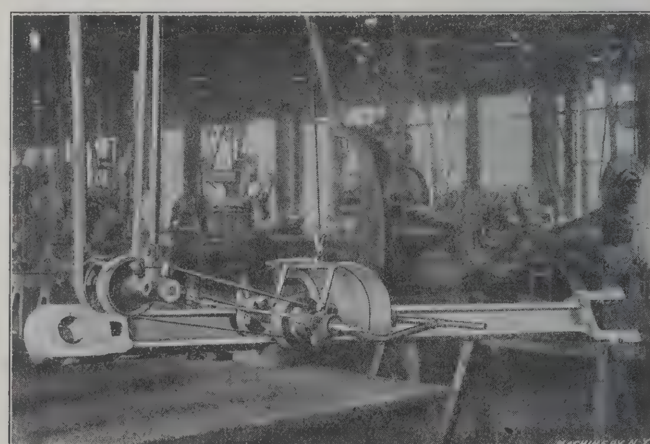


Fig. 19. Grinding and Polishing the Channels on the Main Rod with Suspended Grinder

in the shape of a rectangular block the full width of the head as seen in Fig. 20. The only reason for rounding this oil cup would be to effect a slight saving in weight and appearance. It does not appear that the cost of the operation is sufficient to warrant the slight advantage.

The rod is now finished so far as the machining operations are concerned, and is in the condition shown in Fig. 16, where its weight is shown to be 657 pounds. This, it will be seen, is only one-third of the rough weight of the forging as given

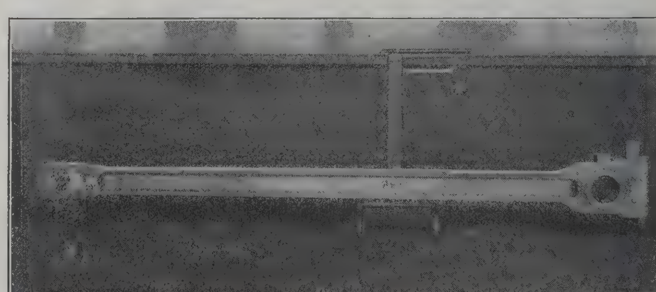


Fig. 20. The Main Rod ready for the Locomotive

in Fig. 4. This is an interesting example of the efficiency of modern machining operations. It would be possible to forge the blank much closer to size than is done in actual practice, so that the amount of metal removed could be greatly less-

ened. It is so simple a matter, however, to remove large quantities of metal with rigid machines and suitable tools, that there is no economy in taking the time required to forge close to size. As a consequence, twice as much metal is cut off and thrown into the scrap as is left in the finished part.

Bench Work on the Main Rod

The main rod now goes to the bench and vise operators, where it is polished and fitted to the parts that go with it, shown in Fig. 17. The polishing is done (see Figs. 18 and 19) by emery wheels hung on counterbalanced swinging frames from the ceiling. These have entirely supplanted the laborious and time-consuming filing operations that used to be employed. The wheels can be manipulated so as to follow flat and round surfaces with equal facility, smoothing out all the roughness of the outlining operations on the heavy milling machines. Fig. 18 shows the wheels smoothing up the round for the swell of the head at the open end. Fig. 19 shows a small wheel with a rounded edge finishing up the corner of the groove in the channel.

In addition to these polishing and finishing operations, the parts shown in Fig. 17 have to be fitted into place. The machine work done is of such a grade that no machine operations are required for fitting these pieces. A little easing with the file and the vise here and there is all that is required. The parts themselves and their uses in the rod will

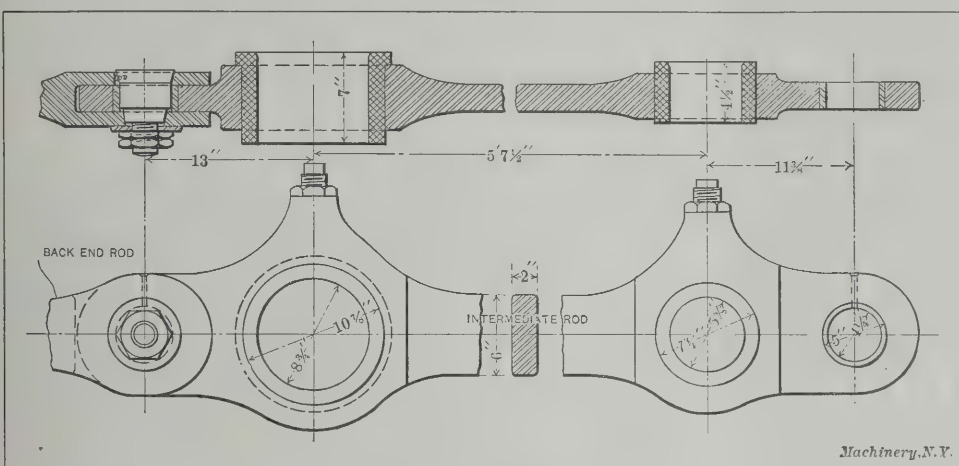


Fig. 21. Details of the Intermediate Rod Construction

be readily understood by reference to Fig. 2. Fig. 20 shows the completed rod on the scales.

Design of the Side Rods

Fig. 29 shows the type of end rod, and Fig. 21 the intermediate side rod used on these consolidation locomotives. Owing to the short center distances between the crankpins, the inertia of the rod as it flies up and down is not so serious

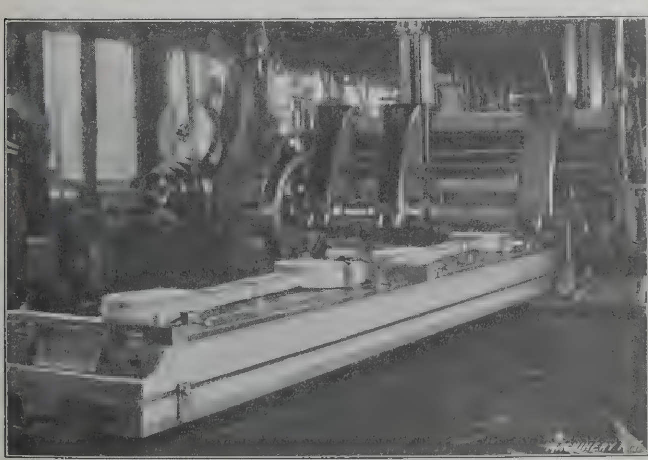


Fig. 22. Finishing the Sides of the Heads of the End Rods

a matter as in the case of the main rod. For this reason, it may economically be made of a plain rectangular section as shown. Solid bushings are used, with no provision for adjusting. When these are worn to a point where further use becomes inadvisable, they are pressed out and replaced with new ones taken from stock. Forked pivot hinges are provided to which the end rods are connected with a knuckle joint, as shown best in Figs. 21 and 34. This is the usual construction for consolidation locomotives. Owing to the

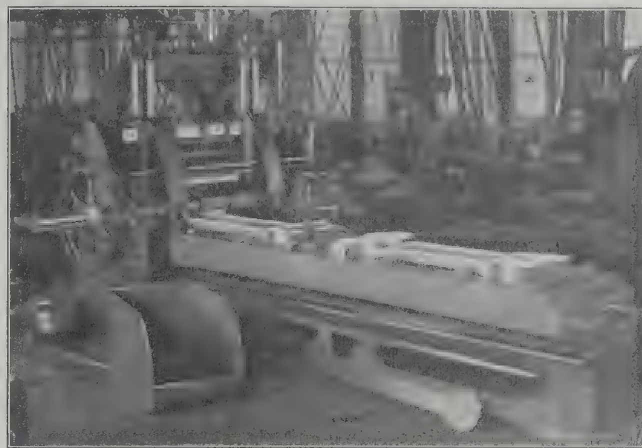


Fig. 23. Finishing the Sides of the End Rods in a Slab Milling Machine

inequalities of the track and unequal wear of the driving wheel tires, there can be no assurance that the driving wheel axles will remain in the same plane, so it is necessary to hinge these rods to give a free vertical movement for the axles with relation to each other.

Split boxes have sometimes been provided for the crankpin bearing for one of the end rods, either the front or back, but this is not now done on this road. Adjustment of center distances is rendered unnecessary at the present time by the exceedingly careful attention to dimensions given in the shop. In machining and inspecting, the distances between the finished surfaces of the frame pedestals of the driving boxes are required to come right within the thickness of a piece of paper, which (as any mechanic knows) is somewhere near 0.005 or 0.006 inch at the most. Under such conditions, end adjustment becomes unnecessary. Such variation in center distances as results from wear affects alike the axle boxes and the crankpin bearing.

Removing the Metal from the End Rod Forgings and Laying them out with Templet

In Fig. 22 is shown the first machining operation on the end rod. Two or four of these at a time are laid on the bed of the planer-type slab milling machine, while the side surfaces of the stub ends are worked off on one side. The forgings have, of course, been packed on the machine so as to rest firmly, and the depth of cut is so gaged as to leave stock to finish out on both the heads and the rectangular sections. The holding of the work is effected by the means common in planer practice, which have been found sufficient for the heaviest cuts on the slab milling machine. Of course the principal strain is against the back stops, and these, it will be seen, are of very heavy construction.

After milling both heads in the manner just described, these end rods are turned over to the templet man, who scribes out on them the outline, the location of the holes, etc., the same as was done for the main rod. They are then returned to the slab milling machine and milled on the top and bottom edges of the rectangular section and around the outlines of the heads, as described for the main rod in connection with Fig. 8, and as illustrated for the intermediate rod in Fig. 30. The templets for laying out these parts are shown lying beside the base of the milling machine in Fig. 23. One of them is for the front end rod and the other one for the rear, practically the only difference between the two being a slight variation in length.

Fig. 23 also shows the next machining operation, which is that of milling the sides of the rectangular section of the end rod. Four of these are mounted in the miller at a time, two cutters being used on the machine spindle. Substantial stops are provided, as shown, for the end-thrust, while the work is held to the table by straps which are moved as may be required to permit the passing of the cutters. After one side is completed, the rods are turned over and the other side of the section is milled.

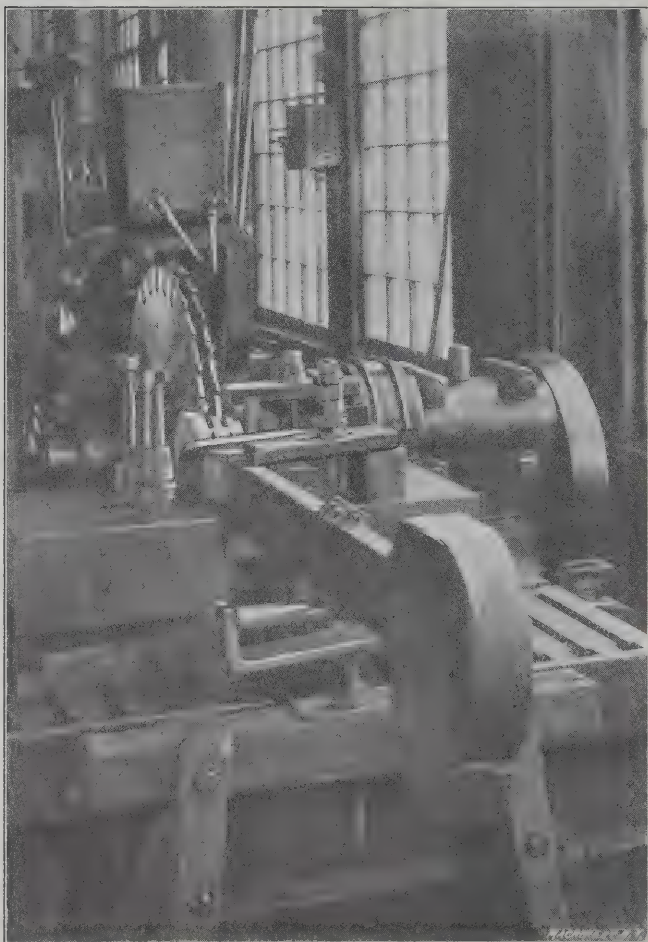


Fig. 24. Cutting out the Knuckle-joint Slot in the End Rod

Working Out the Holes and Openings

The next operation is that of drilling the hole which forms the bottom of the cut made by the double sawing machine, in forming the slot for the hinged connection with the intermediate rod. The saws are shown cutting into this hole in Fig. 24. This is the same machine as shown previously in Fig. 10 at work on the main rods. The outer end of the work is supported on a roller mounted on a screw-jack and trestle for convenience in setting the work. This is not required for the feed of the machine, which is applied to the saw-slide instead of the work-table.

The slot thus roughed out has next to be finished. This operation, shown in Fig. 25, is done on the slotting machine with the same arrangement of tools and fixtures as used on the main-rod operations shown in Fig 12. The roller support for the outer end of the work is here shown to better advantage.

It will be noted by reference to Fig. 29 that these slots are tapered in to the center line of the hole, and have parallel sides from there to the bottom. This taper is comparatively slight, being only 1/16 inch in the whole distance. The tongue of the intermediate rod which enters this groove is similarly tapered at the outer end, and parallel at the inner end. This provides for a slight lateral flexibility in the separate members of the system of the rods. This is a very necessary provision, as it is not practicable to fit the driving wheel axles without end play, nor is it possible to keep them so fitted after they have been in service for a while. The circular table of the slotting machine comes into play in the cutting of the tapered portions of the slot. It is turned slightly to the right hand for one side of the slot, and slightly to the left for the other side, permitting the whole slot to be machined without shifting the work on the table.

The next operation is a very interesting one. It is that of cutting out the stock for the crankpin holes. These holes are not cut out of the solid, the operation being rather one of

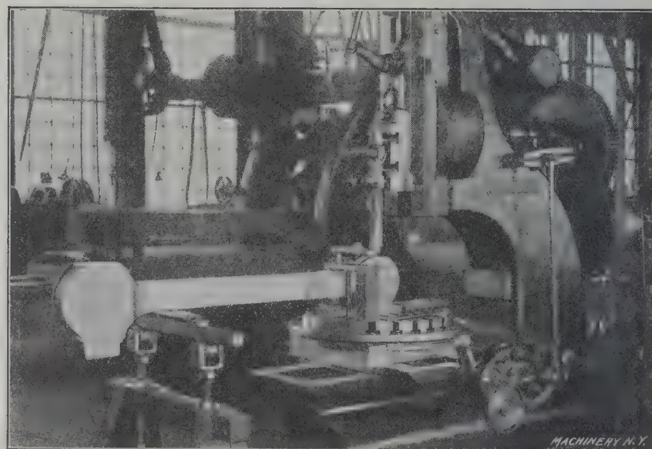


Fig. 25. Machining the Knuckle-joint Slot for the End Rod in the Slotting Machine

trepanning, as it has sometimes been called from its resemblance to the surgical operation occasionally performed on damaged skulls. The work is strapped to the platen of a special vertical double spindle boring machine, as shown in Fig. 26. This machine is powerfully driven by a motor at each end of the main shaft, and is provided with suitable feeds and speeds for rapid work in tough materials. The speed changes are effected by variable speed motor control, while the changes in feed are made by a positive quick change gear device. As shown in the engraving, the tool removes a solid plug of metal from the hole, it being necessary to expend only the power required for removing a comparatively thin chip

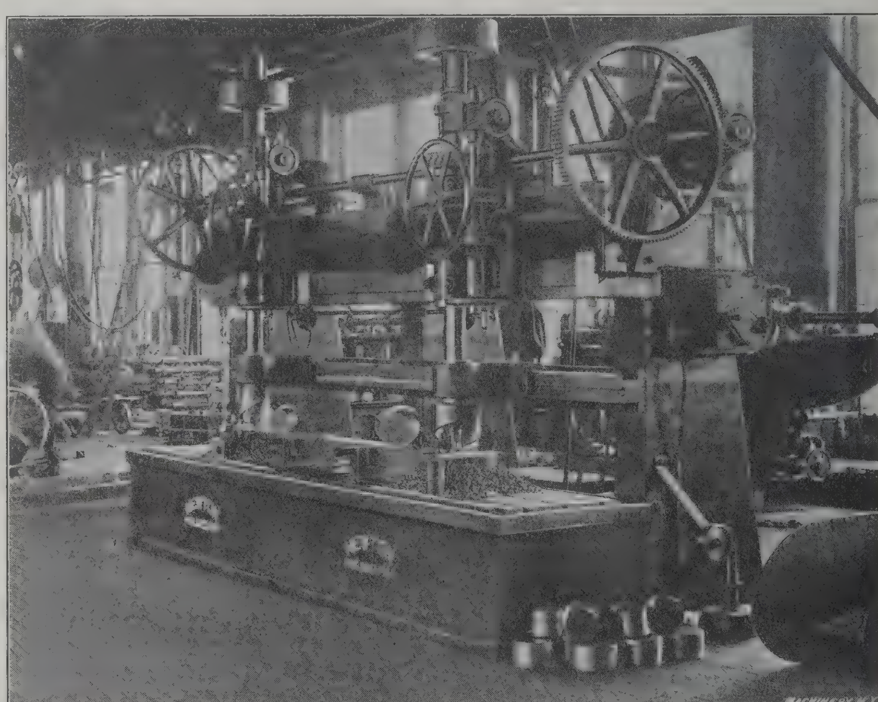


Fig. 26. Cutting the Crank-pin and Knuckle-pin Holes in the End Rod in a Double-spindle Newton Boring Machine

between this plug and the solid wall of metal in the work. Some of the removed plugs are shown in the engraving, lying on the rod, and piled at the end of the machine.

The style of tool used is shown in Fig. 27. As may be seen,

two inserted cutting blades are used, mounted in a cast head of such form as to provide a strong support and at the same time to give ample chip room—a matter of importance in a cut of this kind. Each blade is located by a tongue resting in a groove cut in the holder. It is held in place by tap bolts passing through slotted holes, and an end adjustment is pro-

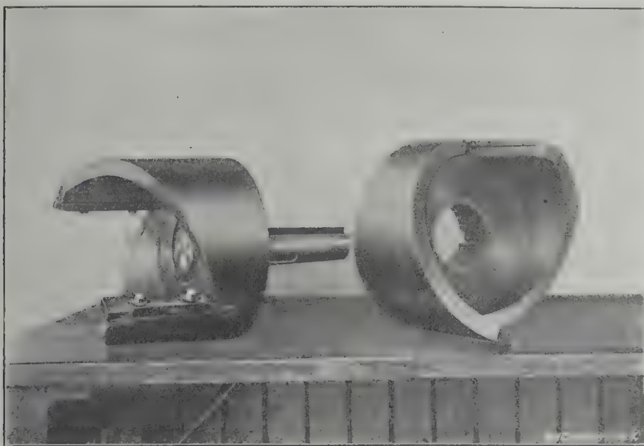


Fig. 27. Type of Tools used in the Operation shown in Fig. 26; These Tools remove a Solid Core from the Hole

vided by set-screws passing through to the top of the holder. This permits the two blades to be set so that each does its share of the work.

The time required to cut out a plug for the 9⅞-inch hole in the end rod in 50-point steel, 4 inches thick, is approxi-

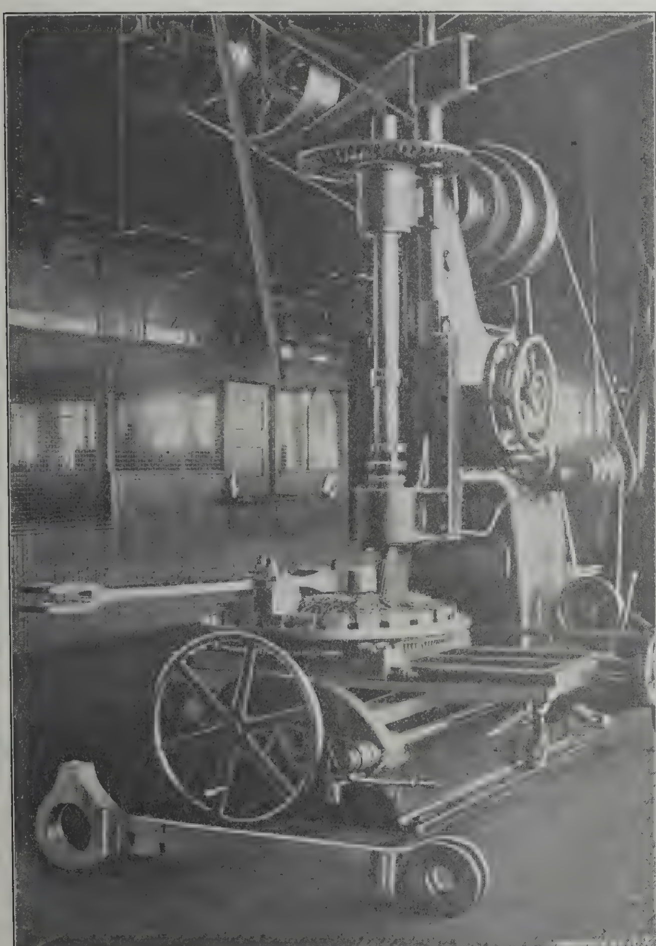


Fig. 28. Machining Circular Outlines of the End Rod on the Vertical Milling Machine with Rotary Table

mately 22 minutes. The capacity of the machine was considerably increased by the support given to the spindles close down to the work. This was designed and added to the machine in the shop. As may be seen, these supports are adjustable lengthwise to follow the spindles in whatever position the latter may be placed. Another convenience is the stops provided on the cross-rail for locating the heads. These clamp firmly on the lower V of the guiding surface and are adjustable to any position. By means of them the heads may be shifted from one definite position to another, so that the four holes met with on the intermediate rods (as will be described later) are bored without taking measurements on any except the first pieces set up. The holes in the rods thus roughed out are finished in the same machine with suitable boring tools and reamers.

While the outline of the end rods has been in part roughed out on the milling machine, so much of this is circular as to

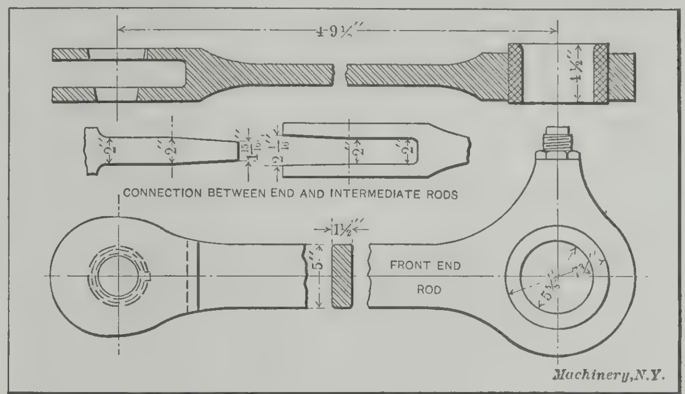


Fig. 29. Details of the Construction of the End Rod

permit its being finished very nicely on the vertical miller in the way shown in Fig. 28. The work is clamped in place on the circular table on the axis, first of the crankpin, and then of the knuckle pin, while the contour in each cut is finished to the proper radius by the circular feed. On this same machine the remaining non-circular portions of the outline are

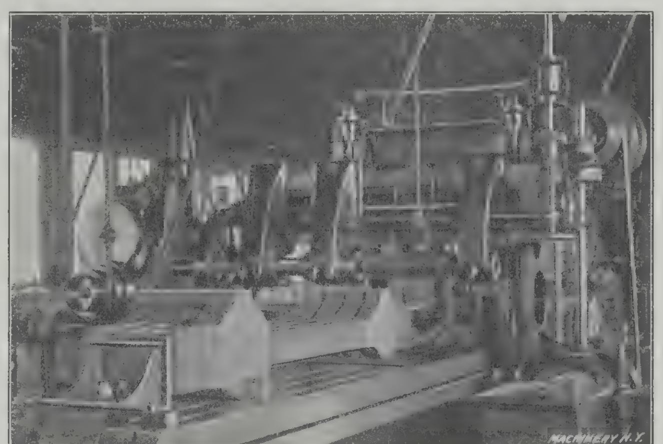


Fig. 30. Cutting the Edges and Outlining the Heads of the Intermediate Rods on the Slab Milling Machine

worked out by hand in a way similar to that described for the main rod on the horizontal miller.

The subsequent operations for this piece resemble similar operations on the main and intermediate rods, so special ref-

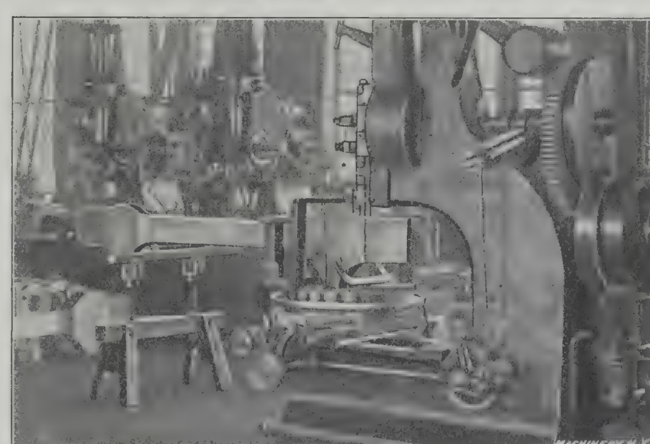


Fig. 31. Finishing the Sides of the Tongue for the Knuckle-joint on the Intermediate Rod in the Slotting Machine

erence will not be made to them. These operations include the drilling, counterboring, tapping, etc., of the oil holes, the polishing and finishing of the surfaces, the fitting of the brasses, etc.

Operations on the Intermediate Side Rod

The details of the intermediate rod are shown in Fig. 21, This has the same rectangular sections as the end rod, and requires solid bushings, simply pressed in place. The holes in the tongue for the knuckle-pin, connecting it with the end rods, are bushed with case-hardened and ground steel, bearing on a pin which is treated in the same way.

The operations are the same as for the end rods, up to and including the milling of the upper and lower surfaces of the rectangular sections. Owing to the fact that there is comparatively little circular outline around the main crank-pin bosses, these are worked out on the slab milling machine by the vertical adjustment of the cross-rail by the operator as shown in Fig. 30, the operation being similar to that described for the main rods. The engraving shows the work set in place in the machine, but not yet clamped down. Care is taken in setting the work to have the outlines scribed by the templet come at the same height at each forging, so that the workman can do four at once and follow only one outline.

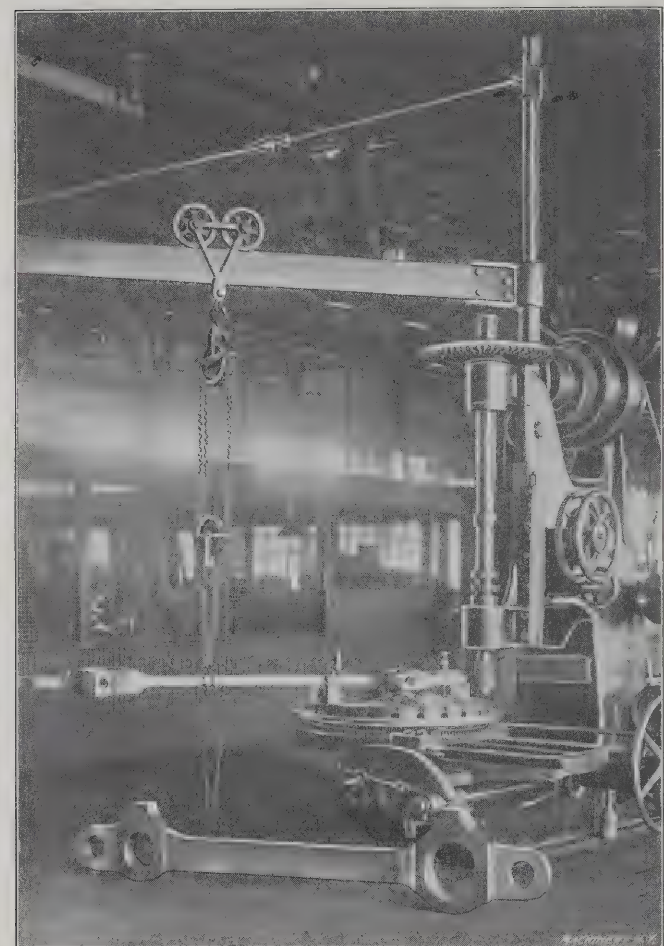


Fig. 32. Milling Circular Outlines in the Intermediate Rods with the Outer End of the Work Supported from a Swinging Arm

The next operation is the finishing of the sides of the tongues, where they fit into the slot in the knuckle joint of the end rods. This is done in the slotter with a tool-holder which permits the blade to be relieved on the back stroke. The operation is shown in Fig. 31. The circular table is used as on the end rod to machine the tapered end of the tongue for the hinged joint. The rolling outboard support and the method of holding the work is plainly shown. The holes for the crankpins and joint pins are worked out on the boring machine in the same way as shown in Fig. 26. The stops on the cross-rail are used for locating the spindles in shifting them from the crankpin to the hinge hole, and *vice versa*, making repeated measurements unnecessary.

The finish milling of the circular portion of the outline of the rod is done as shown in Fig. 32 in an operation similar to that shown in Fig. 28. In this case, however, owing to the greater length and weight of the work, it becomes necessary to support it at the outer end. This is done very handily by a crane swinging from a support on top of the frame of the machine. While the center of the swing of this crane is not concentric with the axis of the table, it is near enough so that very slight adjustment is required in the length of the chain hoist to properly support the outer end, while it is swung around from one side to the other for the circular feed.

The rod is now ready for polishing under the suspended emery wheels previously described, and for having the solid bushings forced into place. This is done under heavy pressure, so that the bushings are squeezed together slightly, reducing their inside diameter. In order to bring this back to standard size again for the fit on the crank-pins, the rods are taken to the double-spindle boring machine shown in Fig. 33, where they are re-bored to size. Great care is taken, of course, to preserve the center distance, and to have the new holes exactly concentric with the old ones—that is, with the holes bored in the rod itself.

After the work of machining on the intermediate and end rods has been done, they are all assembled and laid out on horses, as shown in Fig. 34. Here they are inspected for all important dimensions. Rapid and effective work done in the assembling department of this plant demands great accuracy in the dimensions of the parts produced in the shop. This is the final examination of the work for accuracy in these dimensions and it is very carefully done.

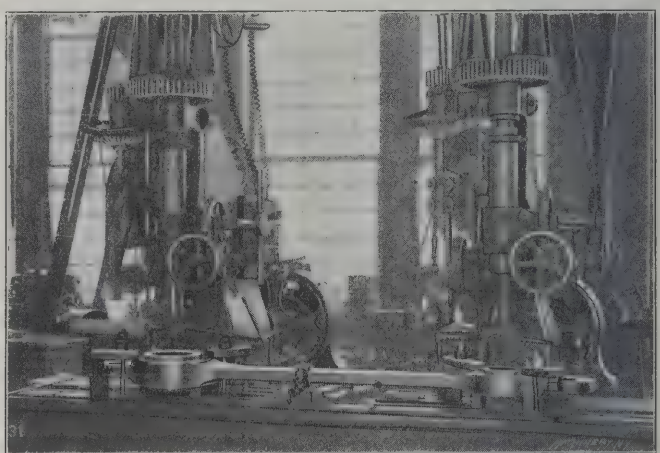


Fig. 33. Re-boring the Bushings in the Intermediate Rods after pressing them into Place

Fig. 34. Intermediate and End Rods assembled and laid out for Inspection

Fig. 1 shows the side and main rods at the place of their destination mounted on a "Type H8B" freight locomotive, the heaviest engine built by the road. This is of the consolidation type, as shown, and weighs on the drivers 211,000 pounds and on the trucks 27,333 pounds, giving a total weight of 238,333 pounds. The cylinders are 24 inches diameter by 28 stroke, and the wheels are 62 inches in diameter. A boiler pressure of 205 pounds is carried, and the engine develops a tractive force of 42,660 pounds—a very satisfactory figure. In this type of locomotive it is not necessary to pare down the weight, so the parts have been made ample for all the strains that will be imposed on them. The result is a construction which was expected, and has so far proved, to be very durable and serviceable. It is probable that, if heavier freight locomotives are ever required for the road, recourse will be had to the Mallet articulated type.

THREAD GAGES FOR BOLT WORK ON FRENCH RAILWAYS

CHARLES R. KING*

The recent construction of French locomotives in the United States entirely to French drawings and metric measures, is an example of what may be done towards a working realization of a universal standard of measure and weight. On the Continent much has been done towards standard screw pitches. These pitches are usually to metric standards, but many German and Russian locomotive builders employ the inch as the basis for their screw threads in all large bolts; the rest being to metric standards. In France most of the railway companies and large engineering firms have accepted international screw pitches, and to arrive at their practical adoption, it has been necessary to introduce special scales as well as to establish a series of master gages for the due control of the fabrication.

The method that has generally been employed, hitherto, for the control of the finished work, consists merely of making standard type bolts and nuts for every diameter used, each couple fitting together and being used for testing the lots delivered to the store. Although every endeavor is made to manufacture bolts and nuts to these standards or theoretical limits fixed by the rules of the international system, it is evident that this method of control leads to the making of master bolts slightly under-size and of master nuts slightly over-size, in order to fit each other, or in other words, the master bolts

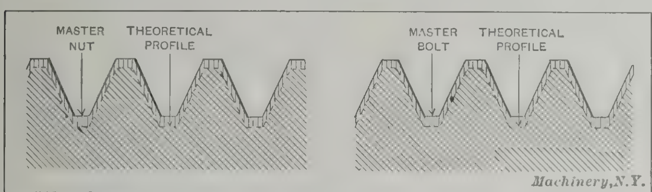
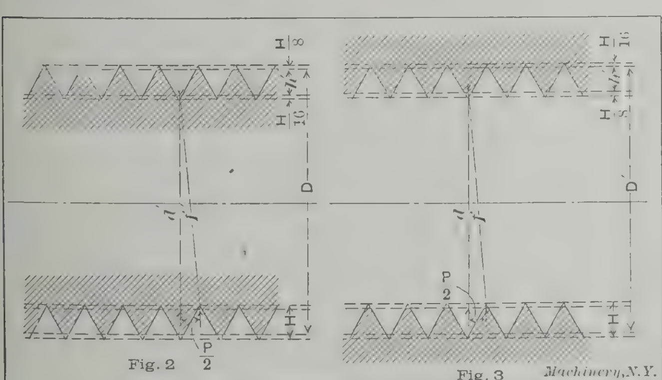


Fig. 1. Master Bolt and Nut Gages made to overlap Theoretical Profile, to insure Interchangeability of Parts Tested

remaining to the inside of the theoretical profile and master nuts to the outside of the same theoretical profile or surface. Such gages answer the condition imposed of fitting the pieces to be tested, but the verification of the profiles is not, as a consequence, certain. In fact, by this method a master bolt may enter a nut that is really cut inside the limits of the theoretical surface, or a master nut may fit a bolt that is actually cut outside of the theoretical profile. Two such pieces so verified by the standards will not fit each other. This inconvenience accentuates with the wear of the master sets for, on account of the difficulty of correcting hardened gages, such gages are not hardened after cutting and, in consequence, they wear rapidly.

The method adopted in France for avoiding this inconvenience is given in the following description of the system employed by the State Railways of France. It consists of making control gages overlapping the theoretical profile. This is



Figs. 2 and 3. Longitudinal Sections through Master Bolt and Nut

illustrated in Fig. 1 showing a bolt cut outside of the theoretical profile, the overlap being shown by heavily shaded lines, and a nut cut inside of the theoretical profile. The bolt and nut do not, of course, fit together, and serve only for testing bolts and nuts that conform to the theoretical profile or intermediate line. Pieces so tested are certain of being interchangeable. As soon as these master gages are worn up to the theoretical profile, they are scrapped, and replaced with new ones. As the master bolt slowly wears away, it tends to pass smaller nuts, and the nut standard tends to pass larger bolts, in consequence of which their wear has the safe defect of ensuring a tighter fit between the bolts and nuts accepted for service the more the wear proceeds.

These excesses from wear of the standards which are given

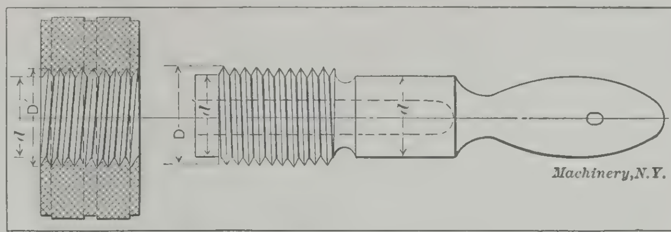


Fig. 4. Master Bolt and Nut

in the following table (increases for the bolts, and decreases for the nuts accepted) are in proportion to the diameters corresponding with the theoretical profiles.

For diameters of 6 to 10 m/m..........	0.020 m/m
For diameters of 12 to 22 m/m..........	0.040 m/m
For diameters of 24 to 39 m/m..........	0.060 m/m
For diameters of 42 to 56 m/m..........	0.080 m/m

Thus for a bolt of 2½ inch diameter the difference due to the wear is considerably under one-tenth of a millimeter.

In addition, in order to avoid contact of the projecting apexes, of pieces being tested, with the base of the threads in the gages, and so giving rise to incorrect control as concerns the degree of perfection approaching the theoretical standard, the hollow apexes of the master bolts and nuts are deepened as shown by Figs. 2 and 3 at $\frac{H}{16}$, instead of conforming to the depth $\frac{H}{8}$ fixed by the rules of the international system of screw pitches; H being the depth of the thread.

In consequence of the foregoing, it is also necessary to provide gages for the outside size of bolts and nuts sent to

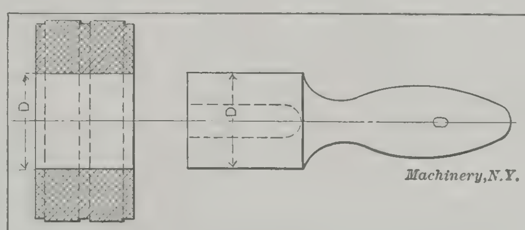


Fig. 5. Ring Gage for Testing Master Bolt, and Plug Gage for Testing Ring Gage

the store, consisting, for the nuts, of a smooth parallel plug gage, similar to the one shown in Fig. 5, whose diameter is equal to the diameter d' at the base of the thread in the corresponding theoretical bolt profile, while, for the bolts, a direct measure is made by a screw gage. The control of the projecting apexes of the master bolt, Fig. 4, is effected by means of a hardened and tempered ring gage, Fig. 5, which, in turn, can at all times be tested by the plug gage (also shown in this illustration), which is hardened and ground. The master bolt, Fig. 4, is turned with two parallel surfaces, one giving its own diameter at the bottom of the thread (see d') and the other (see d) giving the diameter of the projecting apexes in its master nut, and serving to test this master nut.

The various dimensions of the master bolts and nuts are found by the following formulas in which:

D = diameter of bolt at the apex of the thread.
D' = diameter of nut at the bottom of the thread.
d' = diameter of the bolt at the base of the thread.
d = diameter of the nut at the apex of the thread.
f' = oblique diameter of the bolt at the thread base.
P = pitch.

The notation in the formulas also corresponds to the letters used to denote dimensions in Figs. 2 and 3.

* Address: Staple Hill Park, Staple Hill, near Bristol, Eng.

$$d' = D - 2h' \qquad d = D' - 2h'$$

$$f' = \sqrt{d' + \frac{P^2}{4}} \qquad H = \frac{P\sqrt{3}}{2}$$

$$h' = H - \left(\frac{H}{8} + \frac{H}{16}\right) = \frac{13H}{16}$$

The reception of pieces for the bolt stores follows in the routine as here given:

See that all bolts and nuts fit properly on the standards or master sets, Figs. 4 and 5. Measure direct the outside size of the bolts, and test the diameter of the projecting apexes of the nuts by means of the plug gage Fig. 5.

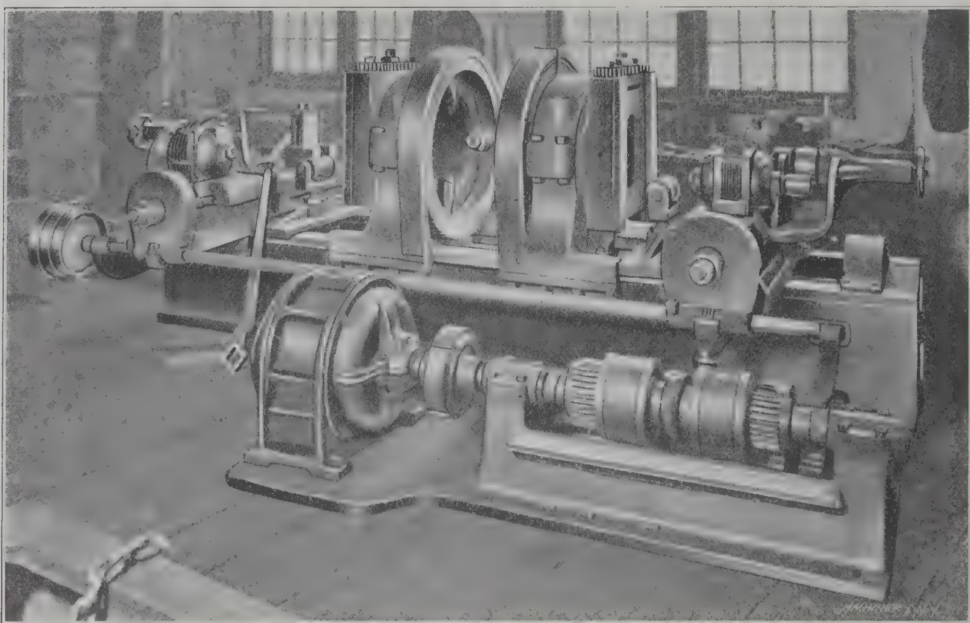


Fig. 1. Rear View of Axle Lathe, showing Electrical Drive, Two-speed Clutch, etc.

* * *

FAWCUS AXLE CUTTING-OFF AND CENTERING MACHINE

The two accompanying engravings show the front and rear views, respectively, of a turning and cutting-off machine recently furnished by the Fawcus Machine Co., of Pittsburg, Pa., for the new axle mill of the Indiana Steel Co., at Gary. These machines are of recent design, and possess features which give them great convenience and productivity on the work for which they are intended.

The rough forgings are grasped by each end in the universal two-jaw box chucks provided at each of the heads, which are set at the proper distance on the bed to agree with the length of the standard gage axle. The two chucks are each geared, as best shown in Fig. 1, with a shaft running through the center of the bed, which is connected by a Morse chain with the driving gearing at the rear of the bed shown in Fig. 1. This is, in turn, connected with the driving motor by means of a flexible coupling and a double friction clutch, giving two changes of speed to the work. The lever for operating this clutch extends through the bed to the front, as seen in Fig. 2.

The cross-slides have each a cutting-off tool mounted at the front, and a drilling spindle at the rear. In cutting off, a power cross-feed is used, operated by the worm gearing and three-step cone pulley seen at the rear of the machine. For centering, the drill spindle heads are brought forward in line with the axle by means of the levers shown on each cross-slide. The drill spindles are each driven by a separate motor mounted on the cross-slides and connected to give the proper rate of speed for the drilling and countersinking; they are fed into the axle end by means of the handwheels shown.

It will be seen that there are no countershafts or belt connections with the line shafting, the machine being motor-driven throughout. The front is entirely clear so that the operator has nothing to interfere with the manipulation of the levers and handwheels. This gives him the freedom of movement necessary for rapid production.

This machine is heavily constructed and built in a way that will stand hard service with the roughest kind of labor. The main driving head bearings are 22 inches in diameter by 8½ inches long. The headstock gears are made of rolled steel rings with cut teeth. The chucks are of forged steel with inserted and hardened tool steel jaws. All the gears throughout the machine are made of steel and every bearing is bushed with bronze.

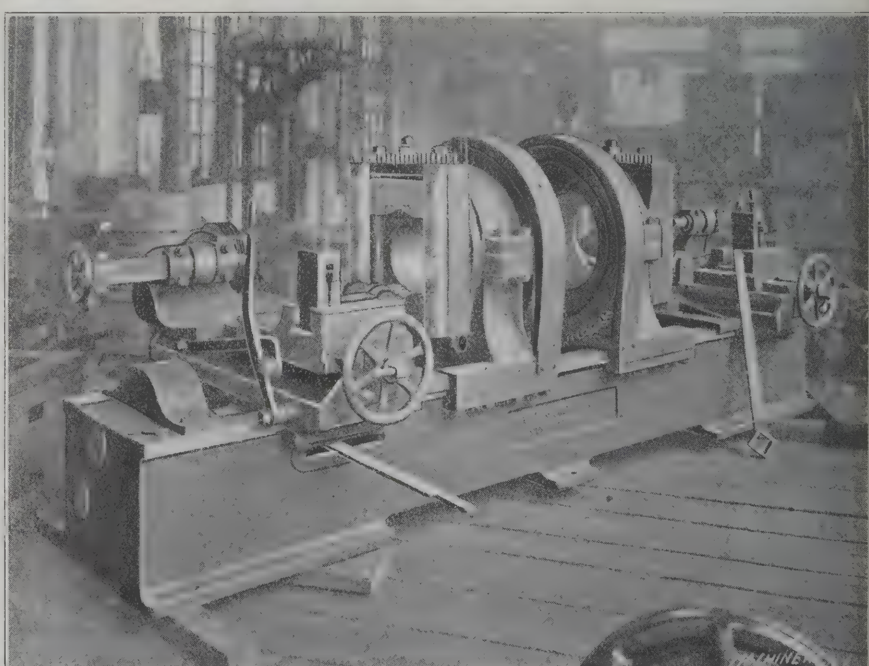


Fig. 2. Front View of a Powerful Special Lathe for Cutting off and Centering Axle Forgings

* * *

MULTIPLE DRILLING AND TAPPING ATTACHMENT

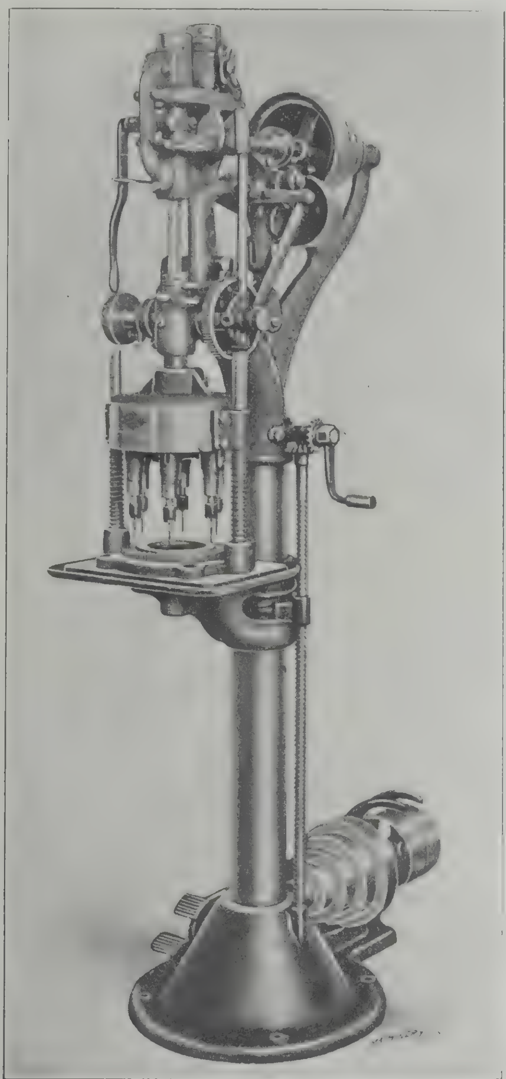
The accompanying illustration shows a 14-inch drill made by the Rockford Drilling Machine Co., of Rockford, Ill. It is provided with attachments for multiple drilling, which are available for tapping as well, since the makers' regular reversing device is incorporated in the construction of the machine.

The work to be done requires the drilling and tapping of 54 holes, spaced equi-distantly in a circle about 6 inches in diameter. These holes are about ⅛ inch diameter, each. The work is done by providing a six-spindle drilling attachment, indexing the work nine times, to complete the 54 holes. The drilling chuck, which is not shown in the engraving, is provided with a spacing device for indexing the work. For tapping, which is the operation shown, the work is spaced around by hand from one series of holes to the next.

The multiple spindle attachment is clamped by a split hub to the end of the regular spindle sleeve of the machine. The six spindles are spaced equi-distantly and are driven from the main machine spindle by gearing. The multiple head is connected with the base of the drilling fixture by means of two upright guides, which keep the work and the spindles in alignment. Coiled springs placed on these guides provide sufficient pressure to counterbalance the weight of the multiple

head, thus enabling it to be raised as quickly as though but a single spindle were being used. This quick return is also, of course, necessary in the tapping operation, and should take place instantaneously with the reversal of the spindle when the handle is thrown which governs the clutch mechanism at the top of the machine.

By the use of this attachment 54 holes, ⅛ inch in diameter,



Multiple Drilling and Tapping Attachment for 14-inch Drill

are tapped at an average of 50 seconds for each piece, using the next lowest speed on the 5-step cone pulley. The drilling operation is, of course, much more quickly performed, the drill being driven at the highest rate of speed the machine is capable of. This arrangement of standard machine, multiple spindle and tapping attachments and indexing jigs is a novel one, and will doubtless find a considerable field of usefulness.

* * *

CASTING CROWN-BRASSES DIRECTLY INTO LOCOMOTIVE DRIVING BOXES

ETHAN VIALL*

The cost of fitting crown-brasses into locomotive driving boxes is always an important item in the expense account of a railroad repair shop, and many are the schemes and devices used to make this item as small as possible. A number of the methods used in the large shops have been described in MACHINERY, but in all probability there is no cheaper one in use than that developed at the Chicago and Alton shops, Bloomington, Illinois. Very likely a few others have used the same method, but none have overcome the difficulties and carried the process to a greater degree of perfection, than has the little group of officials at the Alton shops headed by the master mechanic, Mr. W. J. Hoskin, and the general foreman, Mr. George Gregg. The plan at these shops, is to cast the brasses directly into the driving boxes, thus doing away with the usual machining of the inside of the boxes and the outside of the brasses, and saving, according to Mr. Hoskin, at least seventy-five cents per box.

* Associate Editor of MACHINERY.

The casting of crown-brasses as practiced by Mr. Hoskin and his men, was called to the writer's attention something over a year and a half ago, but at that time the various difficulties encountered and the numerous failures, made the process more expensive than the ordinary method; since then, however, a number of changes have been made in the manner of doing the work, so that at present it is very seldom that the brass fails to hug or cling to the box properly.

The greatest saving effected by casting the brasses direct, is on new driving-boxes in which the dovetail slots for holding the brasses, have been formed in the foundry, as old boxes that have to be dovetailed on the slotter, cost more.

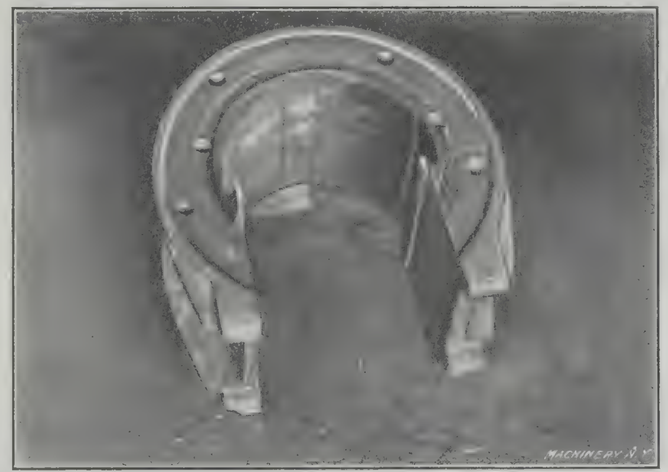


Fig. 1. View of Driving-box showing the three Dovetail Slots which hold the Cast Brass in Place

The way the inside of the boxes are dovetailed, whether in the original mold or on the slotter, is shown in Fig. 1. Besides being cheaper, better results are also obtained on new boxes in which dovetails have been formed when first cast, as the brass "clings" to the rough surface better than it does to the smooth surface of a machined slot. By this it is not meant to imply that the brass fuses or brazes on in either case, but that the brass has a better chance to hold firmly to a slightly roughened surface of this shape.

A group of the mandrels around which the brasses are cast is shown in Fig. 2, though the slots shown in them, which were originally intended to hold strips for forming babbitt slots, are not used for reasons that will be explained later, but are filled up flush with the surface of the mandrel, as shown at *A* on the extreme right.

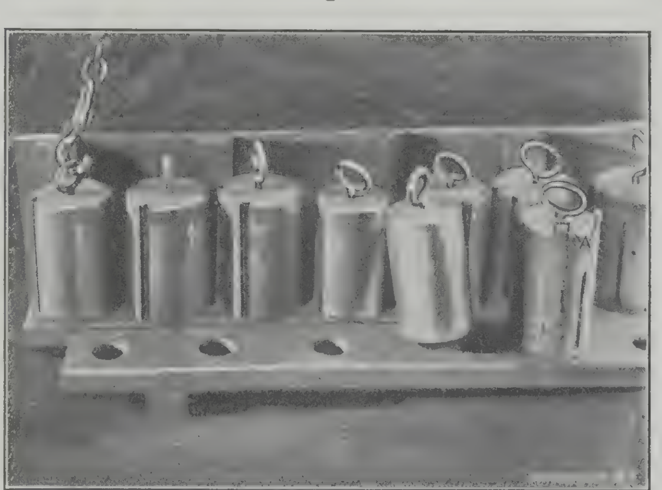


Fig. 2. Group of Casting Mandrels or "Cores"

In order to provide for the shrinking of the brass while it is cooling, the boxes are heated with the mandrel in place as shown in Fig. 3. The heating is done on the outside of the box crown with an oil blast, until the distance across from one of the ends to the other measures one-half inch more than normal. Formerly this heating was done by turning the flame onto the inside of the box, but the oily, sooty film deposited by the crude oil burner proved so troublesome

and caused so many loose bushings, that the method of heating the outside is now used with far better results. It will be noted by referring to Fig. 3 that the box is placed on a heavy cast iron base which has a hole in the center into

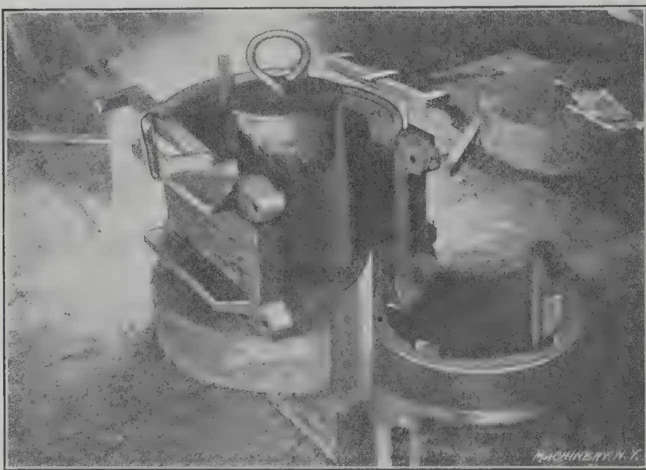


Fig. 3. Box being heated to obtain Proper Expansion

which a plug on the end of the mandrel fits, the box itself being centered by bringing the outside of the crown flush with the circumference of the base. As soon as the box is heated sufficiently to produce the proper expansion, the spaces between the mandrel and sides of the box where the edges of brass are to be, are filled with metal strips wedged in and

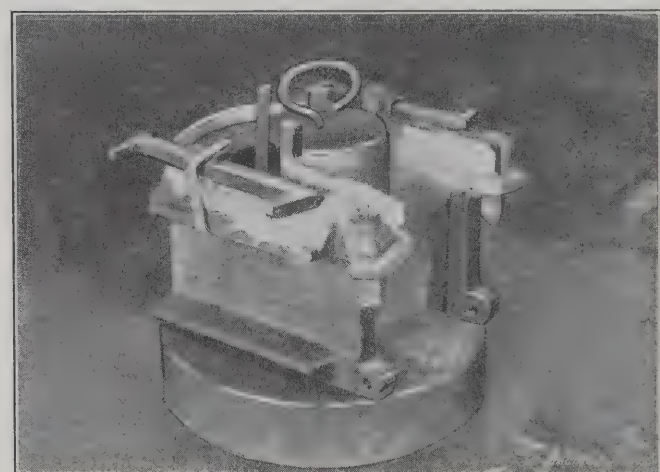


Fig. 4. The Box Luted with Clay and Ready for Pouring

held by clamps on the ends of the box and all cracks are quickly luted up with fire clay as shown in Fig. 4. It will also be seen from this engraving, that a bent piece of heavy strap iron about an inch wide, has been placed on top and clamped so as to allow a heavy brass "flange" to be formed

Fig. 5. Pouring in the Molten Brass

on the end of the crown-brass that goes next to the driving wheel. This is for the purpose of avoiding the heavy coating of babbitt that is put on old boxes when they are fitted up in the regular way, which is another saving point. As soon as possible after the box has been prepared, the brass is poured as in Fig. 5, and a moment later the box is thrown back to cool, leaving the mandrel standing as in Fig. 6.

After the brasses have been cast in, the boxes are taken from the foundry to the machine shop and two dovetail slots are cut in them for babbitt, as shown in Fig. 7. These dovetail slots are not cast in as might be expected, as attempts to do so have for various reasons, proved unsatisfactory,

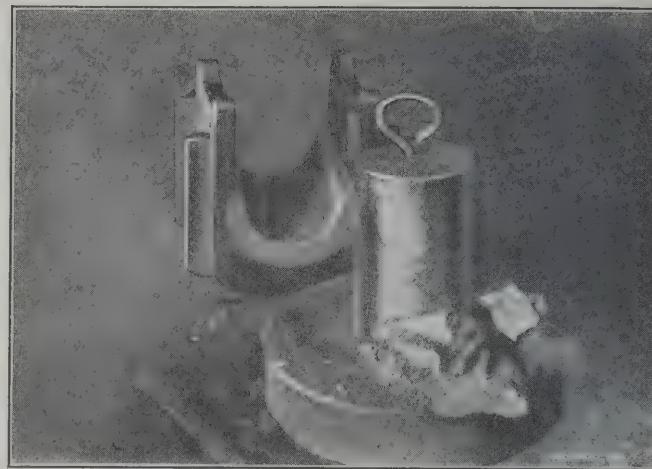


Fig. 6. View of Box with Cast Brass in Place

principally on account of their shape and the great shrinkage of the brass; so they are cut out on the slotter and then after filling them with babbitt, the inside of the brass and the "flange" are turned on a boring mill in the usual way. The thickness of the brass flange is plainly indicated in the engraving.

One of the rather unusual features of the brass foundry is that no crucibles are used for melting, as all the brass melt-

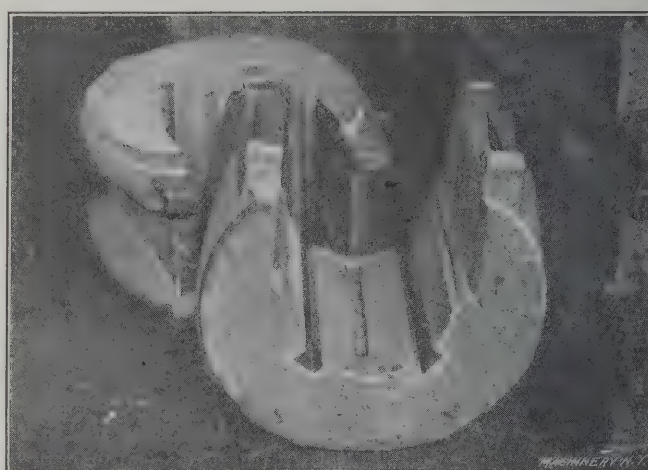


Fig. 7. Boxes after the Babbitt Retaining Grooves have been cut

ing is done in crude oil furnaces of the box type, which are so made that the blast strikes the top of the brass puddle. These furnaces have small openings in the sides for the purpose of skimming off the slag that forms on top of the molten brass. An objection to this form of furnace is that unless considerable care is taken in skimming, pieces of slag are likely to get into the castings and cause trouble; however, both this type and the crucible furnace were tried side by side for some time, which resulted in discarding the crucibles altogether.

* * *

During an entire decade, or from 1900 to 1910, not one passenger has been killed on the Lackawanna Railroad as the result of a train accident, according to a report by the general passenger agent of that road. During this period of ten years, the Lackawanna has transported 193,787,224 passengers —a number equivalent to more than twice the entire population of the United States, or the combined populations of England, Germany, France, Spain and Italy. Each passenger has been transported an average distance of 19.91 miles. The passenger train mileage during this time amounts to 65,340,908 miles.

THE SCHERL GYROSCOPE MONORAIL CAR

A monorail car balanced by gyroscopes in a manner similar to that of the Brennan car described in the December number of RAILWAY MACHINERY, was exhibited in the Clermont Rink, Brooklyn, N. Y., in January, by Messrs. Scherl, Froelich, Rodkinson and others who brought the car to America from Germany where it was invented and constructed. The general appearance of the model car is shown in Figs. 1 and 2, and the construction of the gyroscope apparatus is diagrammatically shown in plan and elevation, Fig. 3.

The car, which is 18 feet long and 4 feet wide, is mounted on two bicycle trucks with double flange wheels. Its net weight is 2½ tons. It is driven by electric motors in the front and rear trucks which are fed by copper wires laid along the rail on either side; these feed wires also supply the current for driving the rotors of the gyroscopes and the motors of the precessional apparatus. The car may run in either direction, there being switches and controllers at both ends the same as on the ordinary street trolley car.

The car balances itself on a single track no matter whether the load is evenly distributed or all on one side. Concentrating the load on one side has the effect of *lifting* that side of the car instead of depressing it. Not only do the gyroscopes balance the car when standing or running on a straight track but when rounding a curve they automatically depress the car on the inner side of the curve so as to offset centrifugal force.

The mechanism that makes this extraordinary action possible is comparatively simple in principle, but its application to a car is attended by a mass of auxiliary mechanism that makes the practicability of this type of monorail car exceedingly doubtful in the mind of engineers. It consists essentially of two gyroscopes mounted with their spindles normally vertical, and driven by high-speed motors. The revolving elements weigh about 63 kilograms or nearly 140 pounds each, the weight of the rotors being about 5½ per cent of the net weight of the car. The gyroscopes revolve at the rate of 7,000 to 8,000 revolutions per minute, and run in a vacuum, it being found by experiments that the power consumption is greatly reduced by exhausting the air. The current consumption is said to be about ten to one as compared at atmospheric pressure and in a vacuum, it being about 2½ amperes at 110 volts in a vacuum. The cases in which the gyroscopes revolve are mounted on horizontal axes at right angles to the length of the car, and the two are connected by toothed sectors so that they work together, but in opposite directions. The rotating elements have a clockwise and counter-clockwise movement respectively, and the precessional movements are therefore opposed. Before proceeding further with a description of the gyroscope apparatus let us briefly examine a toy gyroscope in action, and from that gain an idea of the principles that have made possible this and the Brennan cars which apparently defy the law of gravity.

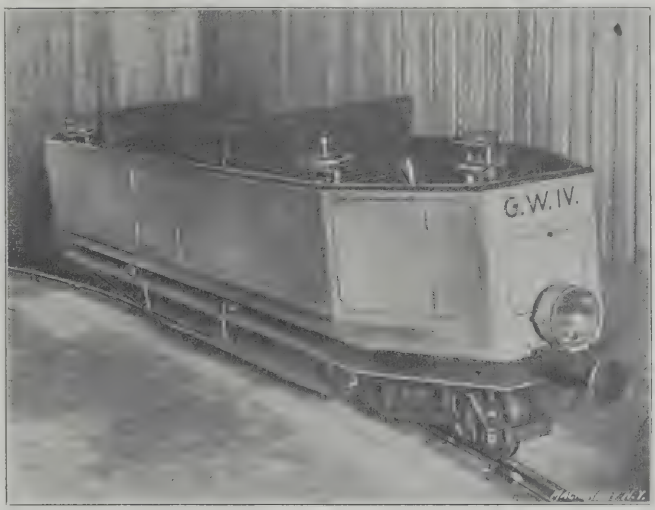


Fig. 2. Another View of the Scherl Gyroscope Monorail Car showing Controllers and Screws at Corners for Supports

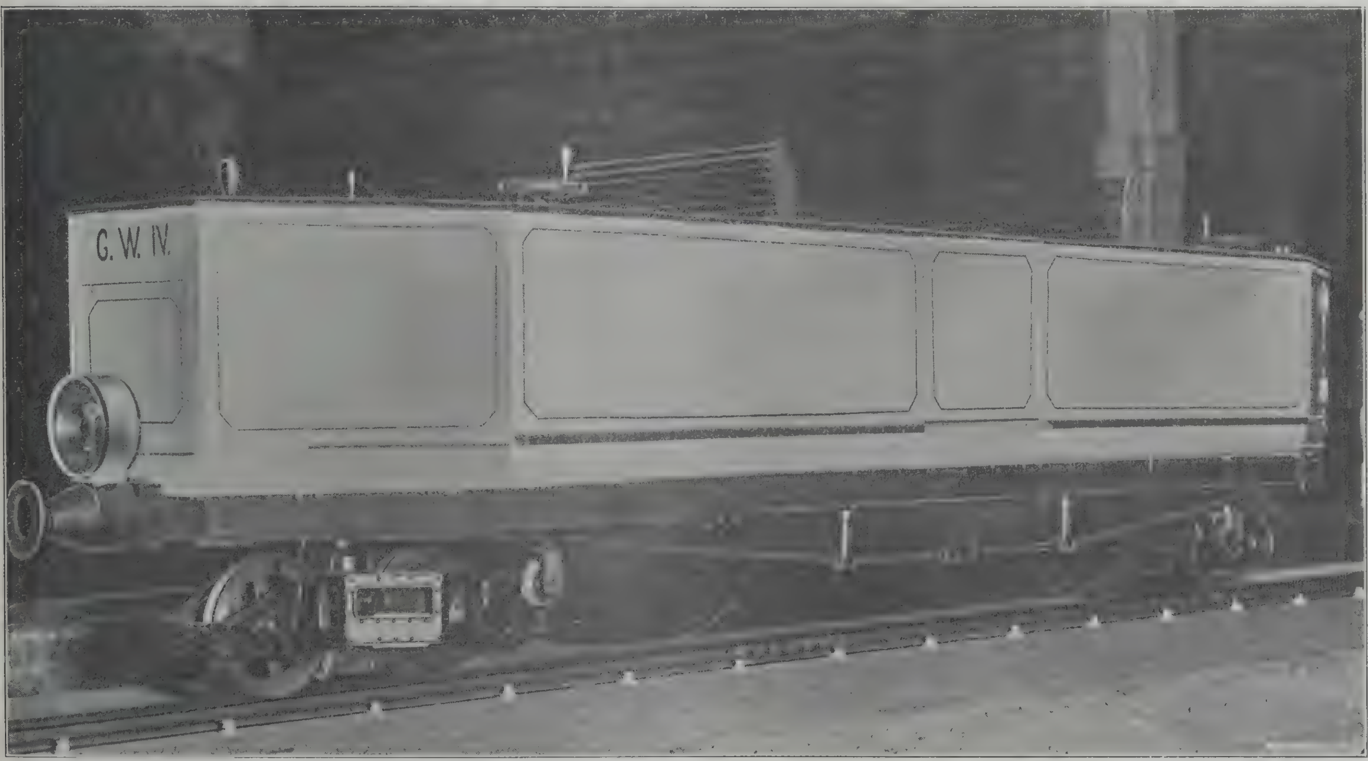


Fig. 1. The Scherl Gyroscope Monorail Car

In the upper view Fig. 4 is shown the plan of a gyroscope that can be purchased in the toy stores for twenty-five cents. The arms D and D_1 were added by soldering on two brass screws. For convenience in reference, numbers have been added to the diagram running from 1 to 12, the same as on a clock face. Now, upon spinning the top in a clockwise direction and supporting the frame B (in which A rotates on the axis $C\,C_1$) with the fingers under D and D_1 a curious action is noticed when D_1 is raised above D: The gyroscope depresses at 12 and lifts up at 6, taking the position indicated in the lower left-hand view. The action is positive, even forceful, with the little toy, the rotating element of which does not weigh more than three ounces. If D is lifted above D_1 the frame tips down at 6 and up at 12. See lower right-hand view. If the rotation of A is in a counter-clockwise direction the effect is reversed, that is, lifting D_1 above D depresses the frame at 6 and raises it at 12, and *vice versa*.

If instead of raising D or D_1 we let an assistant tip the

axis of the rotating element in either direction, a lifting effect will develop at D and a corresponding depressing effect at D_1 or *vice versa*, depending on which way it is tipped. Tipping the axis C towards 12 in the upper view, Fig. 4, with A running in a clockwise direction will increase the load on D_1 and relieve it on D. In other words, if D be depressed and the precessional movement which acts to depress the frame at 12 be augmented by an outside force, a counterforce would develop tending to lift D and depress D_1.

The same principle applies in the action of the gyroscope monorail car. When the car is standing on an "even keel" and the gyroscopes are in operation, the entrance of a passenger momentarily tips the car slightly downward on the side at which he enters. The gyroscopes precess or tip in their frames, and this action operates the pilot valve in the precessional apparatus which is a device essentially the same as the steam steering gear of a vessel. The opening of the pilot valve that is connected to a floating lever throws into action a hydraulic mechanism that tends to tip the gyroscopes still further in the direction that they have tipped owing to the tipping of the car. The tipping of the gyroscopes develops a counter action that rights the car, bringing it back to its normal position. The precessional apparatus is operated through a motor and oil pump which supplies oil under pressure to work the pistons controlling the fore-and-aft movements of the gyroscopes.

There is then a continuous balancing effect going on as the car tips to one side or the other; the gyroscopes in their precessional movements operate the apparatus which augments that precessional movement and thereby rights the car. This action, however, is so dampened that it is imperceptible except when a heavy load is imposed on one side.

In rounding curves, the precessional movement is anticipated by the truck as it enters the curve. The swiveling of the truck operates the precessional apparatus, tips the gyroscopes and depresses the car on the inner side of the curve.

The momentum of the gyroscopes keeps them in operation for a long time after the current is shut off, so there is no immediate danger of the car tipping over should the current be interrupted. It is claimed to be sufficient to keep the car upright for an hour. The car is provided with posts or legs which are screwed down with four hand-wheels at the corners to support it in an upright position when the gyroscopes are out of action.

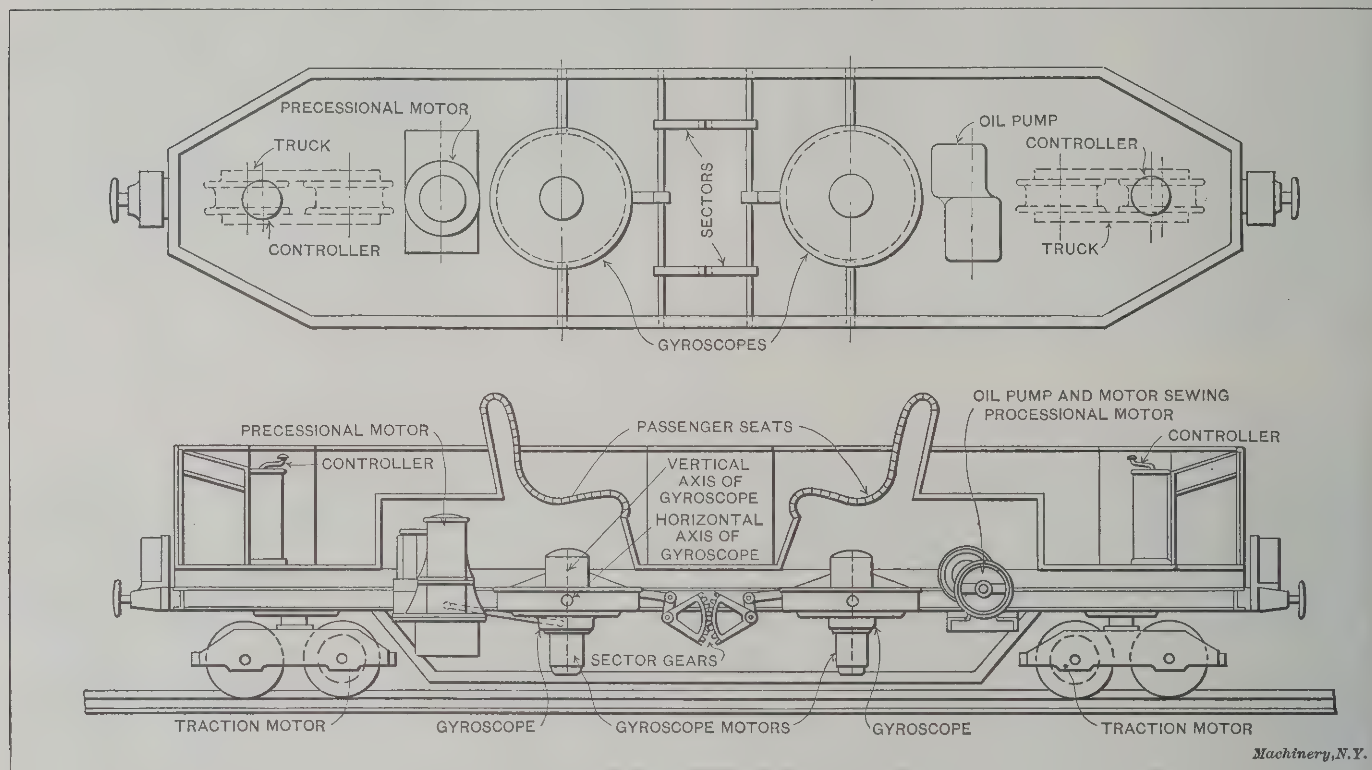


Fig. 3. Plan and Elevation of Scherl Gyroscope Mechanism showing Principle Diagrammatically

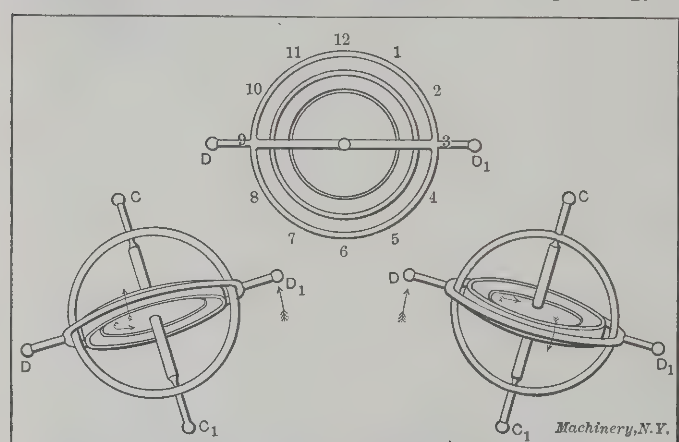


Fig. 4. Illustrating the Principle of Gyroscopic Action with a Gyroscope Top

The practicability of the gyroscope car for ordinary railroads is doubtful. The balancing apparatus runs at very high speed and requires costly and complicated auxiliary apparatus. It should, however, have a field in amusement enterprises where its spectacular features would attract and amuse holiday crowds. In time of war there is a bare possibility that the gyroscope car might be advantageous because of the simplicity of laying single track and the fact that lateral grading is largely unnecessary, the car being able to balance itself and run on an even keel no matter whether the ties and track are level or not. A larger future would appear to exist in the automobile. It seems feasible to construct an automobile on the bicycle principle balanced by gyroscopes that could be run almost anywhere. Such machines might be useful in time of war and in exploring, and for rough work generally. The most practical use that so far has been made of the gyroscope is that of the Schlick apparatus for preventing the rolling of ships at sea.

Besides the claim for cheapness of track grading and aligning, the promoters also claim the possibility of making very high speeds—speeds much greater than possible with ordinary railway trains. The higher the speed with the ordinary railroad train the longer must be the radii of the curves. With the monorail gyroscope car, sharp curves may be rounded at speeds as high, it is claimed, as 120 to 150 miles an hour because of the car automatically tipping inward on the curve to offset the effect of centrifugal force.

The promotion of the company controlling the Scherl and Froelich patents in America is in the hands of Mr. Charles R. Flint, 25 Broad St., New York.

MAKING HEAVY CHAIN AND ANCHORS FOR UNCLE SAM

CHESTER L. LUCAS*

"In time of peace prepare for war" is an old adage that seems to be especially heeded by the great naval powers of the world. Forward strides have been made in methods of naval warfare, and the achievements in building battleships and their equipments have been little short of marvelous. One of the primary requisites of a battleship is speed, and while we hear much of the results along this line, little has been said of the modern methods that are employed for anchoring and holding in check these valuable warships; for it must be remembered that a battleship can go to destruction as quickly on a reef as under the enemy's fire. Realizing the importance of this factor, the United States government has a well-equipped department at the Charlestown Navy Yard wherein every link of chain and every anchor used in the navy is made. Through the courtesy of Commander H. E. Parmenter, MACHINERY's representative was allowed to photograph and record the various processes and machinery used in chain and anchor making.

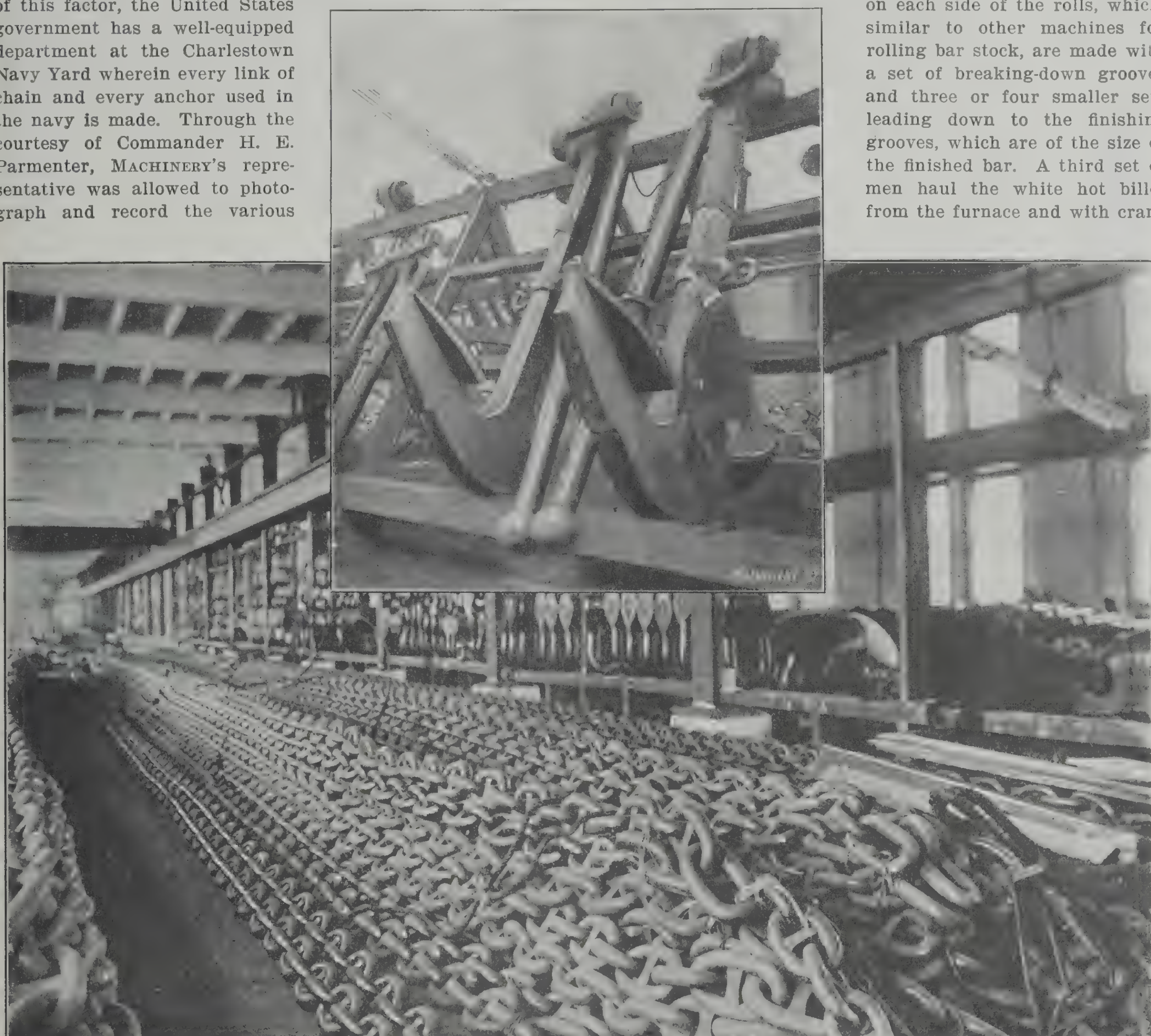


Fig. 1. Anchor Chain Storage, and 17,500 pound Anchors

The Iron

But one make and one quality of iron is used for the heavy chains in the navy, and by heavy chains are meant those with links made of bars from 2½ inches to 3¼ inches in diameter. This iron comes from one of the best makers in Pennsylvania, and is received in square muck-bars 1⅜ inch in diameter. It is accepted only after passing the rigid physical and chemical tests imposed by the government. One requirement of the chemical test is that the percentages of sulphur and phosphorus be very low. By getting the iron in the muck-bar, it is assured that the metal has received the lowest number of heats possible before the chain-smiths of the navy yard begin to work it.

* Address: 4 Bailey Avenue, East Saugus, Mass.

Rolling the Bars

The first step in making the heavy chain, taking for example the 2½-inch size, is to cut the muck-bars to lengths of about 2 feet, the cutting being done cold by means of large alligator shears. These short lengths are then wired into bundles of about 25 each. As these bundles weigh from 250 to 300 pounds, they are handled with crane-tongs and in this manner slid into the huge furnaces. From the furnaces these white hot billets are passed to the rolls and converted into bars of the required diameter—in this case 2½ inches. Fig. 2 shows a view of the rolling department of the chain shop with the furnaces on the left and the rolls on the right. The chain shop is in charge of Mr. William Kelley. In front of the furnaces may be seen piles of cut muck-bars ready to be bundled for the furnace. During the rolling operation, two men stand on each side of the rolls, which, similar to other machines for rolling bar stock, are made with a set of breaking-down grooves and three or four smaller sets leading down to the finishing grooves, which are of the size of the finished bar. A third set of men haul the white hot billet from the furnace and with crane tongs rush it to the breaking-down rolls. To successfully start the billet through the first set of grooves is the hardest part of the rolling, but as this set of grooves is made with short, c'eat-like teeth, the metal is sent through without much trouble. Fig. 3 shows the starting of a white hot billet. If the iron starts to slip, a handful of sand is thrown in and the slipping tendency overcome. After the iron has gone through the breaking-down grooves it is passed back over the rolls and entered in the next set. As the metal is passed through the smaller grooves in the rolls it is, of course, stretched to a greater length, and after the last set has been passed the bar is ten feet long, and the rolling time has been so short that the iron is still at a bright red heat.

Cutting and Bending

From the rolls it is but a few steps to the hot-saw which cuts the bars to the proper lengths for the links. The hot-

saw itself is about 4 feet in diameter and travels with a peripheral speed of 20,000 feet. At a 30-degree angle to the saw is set the table, which is provided with a vise to grip the bar while cutting. The table is set level with the floor, so there is no unnecessary handling of the hot bars. The purpose of cutting the iron bars at a 30-degree angle is to provide for the scarf, so essential to welding. Some idea of the capacity of this saw may be obtained when it is realized that a 30-degree cut through a 2½-inch bar (a cut 5 inches long) is made in 4 seconds.

The two machines shown in Fig. 6 are for bending the links. They are very simple but ingenious machines, and they form the links much better and in a fraction of the time that it would take to do it by hand. Both of these machines were designed by Commander Parmenter and made in the machine shops of the Charlestown Navy Yard under his supervision. The smaller machine is for chain made from 2½-inch stock, while the larger one takes stock from 2¾ inches to 3⅛ inches. The action of the machine, which is in reality a press, is very simple and easily understood. The forming

Fig. 2. General View of the Chain Shop

arbor, shaped like the inside of the link, is located just inside of the oval opening at the front of the machine. The groove around this arbor is spiral, so that as the iron is bent to the shape of the link, the ends will be separated enough to allow the links to be connected before welding. On either side of the central opening may be seen the two cam grooves that guide the forming rolls that bend the link. The bar from which the link is to be made is inserted at the left-hand side of the press; the ram descends, carrying the forming rolls (which are mounted in slides to provide for lateral movement)

Fig. 3. Starting a White-hot Billet through the Rolls

down the grooves, thus giving the link-shaped motion that does the forming. After the link is bent, the arbor recedes, allowing the link to drop to the opening at the base of the machine. All of these operations of rolling, sawing and bending, from the time the billet leaves the furnace for the first time, are performed in one heat and when the link drops from the bending machine it is still at a good red heat.

Welding and Testing

In the welding department there are about a dozen fires with their "chain-gangs" for welding the links. These fires

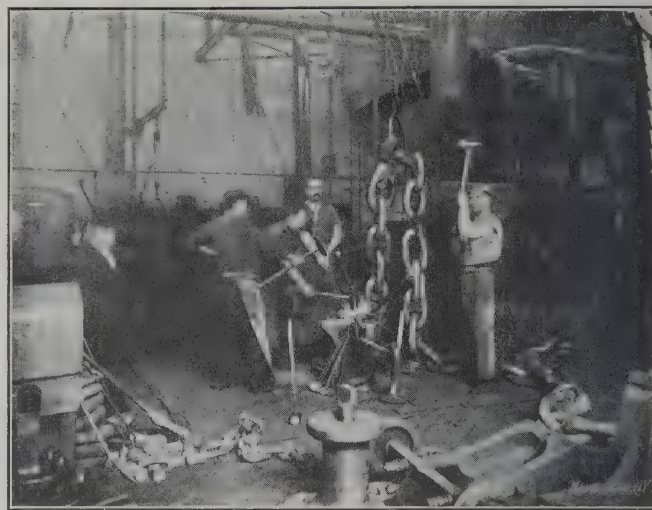


Fig. 4. The Chain Gang at Work Welding a Link

use coke for fuel, and at the side of each one is a constantly growing chain of completed links. Fig. 4 shows one of these fires with its crew at work welding a link. For some of the chain a welding machine is employed, but most of the work is done as shown in the illustration. After connecting the uncompleted link to the rest of the chain, the slack of the finished chain is pulled up out of the way by the hoist shown and the link to be welded is bent together. Next, the joint is placed in the fire and heated without heating the rest of the chain any more than can be helped. When the welding heat

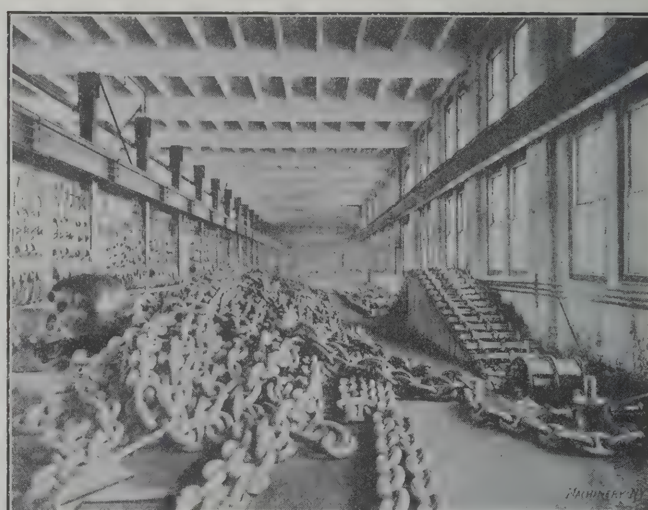


Fig. 5. Chain Painting Apparatus and Chain Ready for Painting

is reached, the link is quickly transferred to the anvil and the strikers send in the blows, under the direction of the smith, who handles the link. The rapidity with which this welding is done is surprising, considering the fact that the chain has "a string tied to it" that makes it awkward to handle. After welding, a drop-forged block is placed in the center of the link and the sides of the link closed in upon it, holding it firmly in place. Each block has the letters "U. S. N." raised upon each of its sides, and while this block does not add to the strength of the chain,* it has a purpose, which is to prevent the chain from kinking and catching while stored away in the hold of the battleship.

* According to Unwin the British Admiralty rule for the proof test of studded cable chain is: Test load in tons (2,240 pounds) = 18 d^2, corresponding to a load of about 11½ tons per square inch of section. For close-link crane chain without studs it is: Test load in tons = 12 d^2. The stud chain thus is subjected to a proof load 50 per cent greater than close-link chain. However, tests made both abroad and by the Boston Navy Yard have shown that the stud does not add to the ultimate strength but rather detracts from it. The function of the stud is essentially to insure the chain running freely from the chain lockers and prevent it becoming rigid under heavy strains.—EDITOR.

Testing and Finishing

The testing apparatus used to prove the quality of the chain is very powerful and the result is conclusive. Owing to the location, it was impossible to obtain a good photograph of the apparatus. The chain is placed in a steel-lined pit, 100 feet long, 3 feet wide and 3 feet deep while under test. A length of chain 90 feet long is made fast at one end of the pit and the other end attached to the testing machine. With this machine it is possible to subject the chain to a strain of 80,000 pounds, this being accomplished by using hydraulic pressure. From each length of chain three links (called a triplet) are taken and tested to destruction. This test proves the chain beyond all doubt, and no poor or weak link can possibly "get by."

At the end of the testing pit there is a steel subway that leads to the storehouse on the other side of the street. A thirty horsepower winch furnishes the power for pulling the chain through the subway. Fig. 5 shows a view of one side of the storehouse, with a pile of chain waiting to be painted. At the right-hand side of the engraving may be seen the device that is employed for painting the chain. Just under the drum in the foreground is the paint tank. The paint, which is black asphaltum, is kept hot by the steam pipes running through the tank. The chain is passed through the tank and

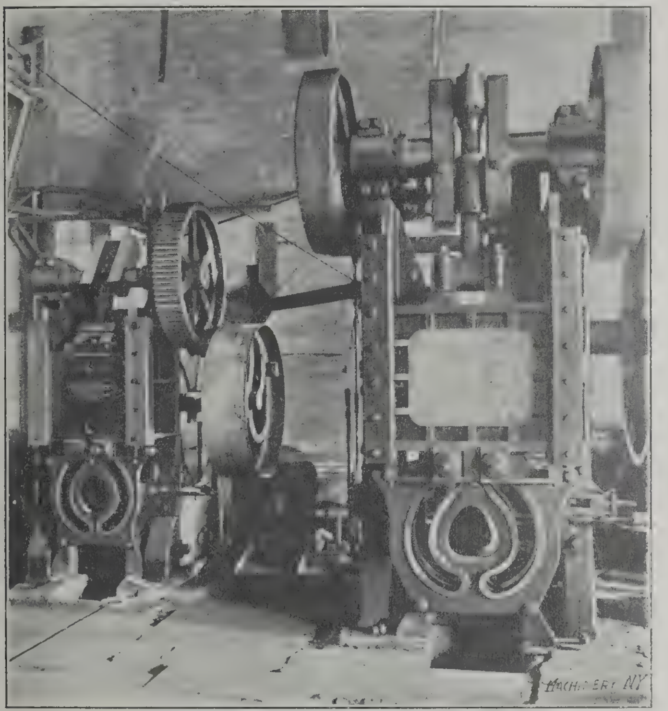


Fig. 6. The Link Forging Machines

under the steel drum and then over the inclined rollers. Another thirty horsepower winch at the farther end of the building is used to draw the chain through the tank and over the rollers. As the paint is applied hot and the chain is drawn over the rollers very slowly, the paint is dry by the time the chain leaves the apparatus. The other side of the chain storehouse is shown in Fig. 1. This view shows more clearly the blocks in the links. Here again the floor is literally lined with chain, and one would think that there was chain enough made to last the navy for years, but when it is remembered that the life of a chain is limited, being scrapped as soon as re-testing proves it to have lost its elasticity or to be otherwise defective, it can be easily seen that Uncle Sam's chain-making industry is an important one.

Anchor Making

The anchor shop of the United States Navy is located in the same large building as the chain shop, and while it is not as large a department, it is fully as important. The work is in charge of Mr. William Paul, whose experience in this line is without a doubt unequaled in this country.

Material and Equipment

In this shop are forged all the anchors for the navy. They vary in size from 400 pounds to 17,500 pounds. The material from which anchors are made is simply the scrap from the process of chain-making—imperfect links, short ends, etc. Fig. 7 shows a pile of this waste chain iron ready to be made into anchors. At the anchor shop it is made into billets of sufficient size to make the various anchor parts. These rough masses of iron are held and worked on huge porter bars, which for the large anchors are 6 inches in diameter and about 12 feet long. The furnaces are of the same type as those

Fig. 7. A Pile of Scrap Chain from which Anchors are made

used in the chain shop, burning soft coal for fuel. Oil furnaces have been tried, but were discontinued for reasons of economy. The steam hammers—and there are six or eight of them—range up to twenty horsepower on the large work.

The Anchor and its Parts

As has been intimated, anchors are built up of several parts, each of which is forged at different fires, according to the size of the work. The parts of an anchor are the two palms, the crown, the shank, the stock and the shackle. The stock and the shackle are not parts of the main anchor forging, though they are very essential to the proper working of the anchor. The stock is to insure the anchor falling in such a position as to grip firmly, and the shackle is the connecting link for attaching the chain. Referring to Fig. 8, *A* is the shank, *B* the crown, *C* the stock, *D* the shackle, and *E E* are the palms. The palms, however, are only called by that name before they are welded to the crown. In the completed anchor, the ends of the crown with the attached palms are known as the flukes.

The System of Forging

In everything that Uncle Sam does there is a common underlying factor that enters into every detail. That factor is system, and it is right at home in the anchor shop as well as in the chain shop. A small model anchor with correct proportions has been made and from that model the weights and measurements for the various sizes of anchors have been computed. Each anchor, then, has its standard size and weight, which is a great aid to the blacksmith. The palms, as forged, are merely flat pieces, triangular in shape and quite thin. The shank is forged with a flat end to be welded to the crown, and holes are forged in the top end for the stock and shackle. The crown is forged with a recess to receive the end of the shank when making the box weld. Through the ends of

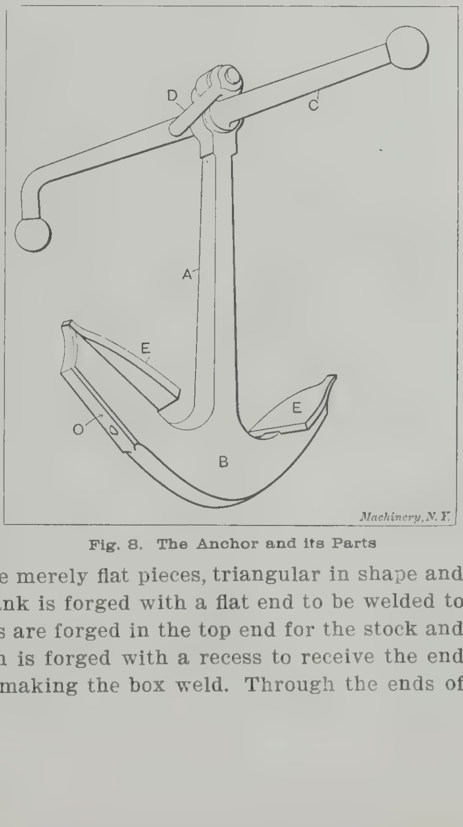


Fig. 8. The Anchor and its Parts

the crown are two holes which are used to hold it to the porter-bar while it is being shaped and welded to the shank. After the anchor is finished, the holes are extended through the palms and a large rivet put through and headed over. This rivet serves no purpose other than to improve the looks, unless it be to keep the elements from the interior of the iron. A glance at the anchors shown in Fig. 9 illustrates this point. At first thought it is natural to think that the rivet helps to hold the palm to the crown, but as these two parts are united by a weld it is plain that the rivets cannot add to the strength. After the forging of the crown and shank is

Fig. 9. A Pile of 3- and 5-ton Anchors

finished, they are heated in separate fires and box welded together. The anchor is now complete except for the stock and shackle. These parts are not added until the last thing. The stock is a plain forging and needs no comment. In putting the balls on the ends of the stock, it is, of course, necessary to leave one of the balls off until the stock is put through the anchor, after which the ball may be headed over. The shackles for the small and medium-sized anchors are forged in quantity. These shackles are made from round bars of the size of the body of the shackle, the ends being upset to form the eye. The holes in the eyes and the shaft that enters the

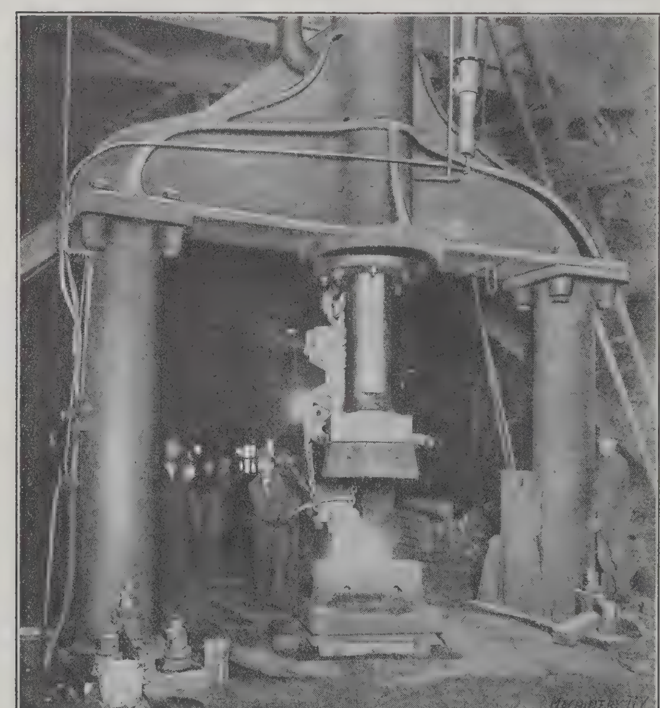


Fig. 10. Forging an Anchor Crown under a 20-ton Steam Hammer

holes are slightly oval so that they may be easily assembled correctly. The shaft is held in place by a taper key, called the fore-lock pin. To bend these shackles and still keep the iron up to its full size, was a problem that Commander Parmenter solved very neatly. The tendency is for the iron to stretch and so flatten out around the bend, thus materially weakening the shackle. He designed a simple and powerful bender that presses the ends of the piece hard up towards the bending point while the shackle is being bent at the same time, thus supplying the extra stock necessary to make a full bend. Fig. 10 shows the 20-ton steam hammer at work putting the finishing touches on one of the flukes of a medium-sized anchor. In this case, as the anchor is not a very heavy one, the crown is being held by the crane and guided by using large tongs instead of the porter-bar used on the larger work.

Costs and Accuracy of Anchor Forging

While the description of anchor forging is not a lengthy one, the work of making a 17,500 pound anchor takes a number of men 27 working days. As the material in the shape of crude iron costs in the neighborhood of eighty dollars a ton and the men receive from three to five dollars a day, it is not hard to realize that the cost of one of these large anchors runs up into four figures.

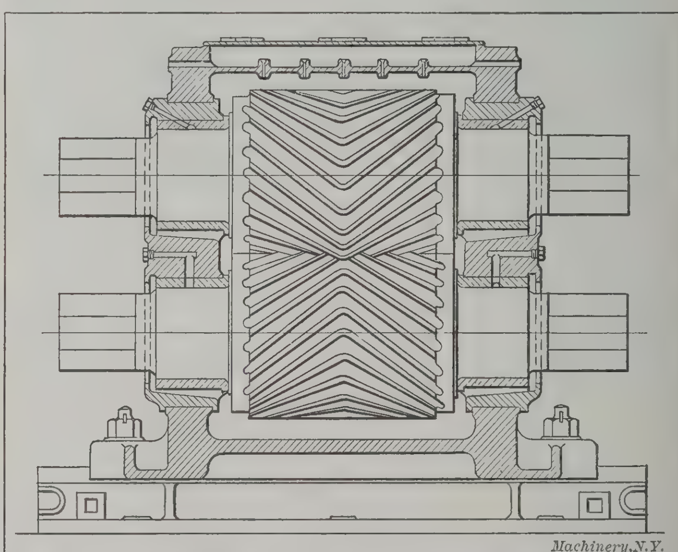
Fig. 9 shows some finished anchors weighing from 6,000 to 10,000 pounds. The two anchors shown in the upper part of Fig. 1 weigh 17,500 pounds each. As the battleships are constantly increasing in size with every new model, the anchors and chain must keep pace (a 20,000-pound anchor is under consideration at the present time), so it is hard to say when the limit will be reached. Upon each anchor the actual weight is stamped in large figures. A few of these figures were copied off as follows: 17,550, 10,030, 9,080, 10,040, 6,004, 5,975. As these anchors were made for 17,500, 10,000, 10,000, 10,000, 6,000, 6,000 pound anchors, respectively, the figures show how closely the work is done, a fact due to the system of proportional sizes that is so closely adhered to by Uncle Sam's experienced anchorsmiths.

* * *

DOUBLE HELICAL CUT PINIONS FOR ROLLING MILLS

JOSEPH G. HORNER*

The steel pinions which drive the rolls of rolling mills have hitherto usually been cast in molds made by tooth-blocks in a gear wheel molding machine. Messrs. P. R. Jackson & Co., Ltd., of Salford, Manchester, England, who are probably the largest manufacturers of cast gears in England, have now constructed a plant for cutting the teeth of rolling mill pinions of double-helical forms, or straight when required. It follows that such gears must be enclosed in an oil box in order to secure the fullest efficiency and durability. They are, therefore, fitted in enclosed housings with oil supply tank above as shown in the accompanying illustration. The advantages of smooth running, reduced blacklash, and greater durability, should more than compensate for the higher first cost of these gears over ordinary cast pinions.



Machine-cut Double Helical Rolling Mill Pinion in Enclosing Housing

* * *

Blue ink lines on tracings seldom show up clearly on blueprints, but if a quantity of orange ink is mixed with the blue the line is made opaque.

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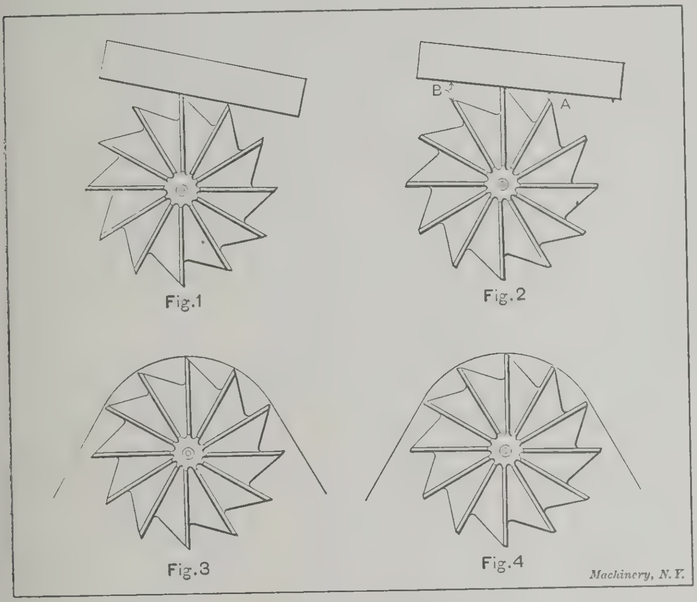
EXPERIENCES OF A YOUNG TOOLMAKER*

T. COVEY

On reporting to his foreman that the surfacing mills were ready to be hardened, Jim was told that his next job would be to grind up the end mills that he had made. Mr. Corbin took him to the grinding room and showed him the machine that he was to use to grind the shanks, and sent him to get the same gage that he used in turning the shanks. On his return Mr. Corbin said, "Whenever you are setting up a grinder for a job like this, you should keep the wheel well away from the work until you are sure that the stops that trip and reverse the traverse feed of the wheel are properly set, as otherwise the wheel is liable to run into a shoulder on the work or the footstock of the machine and either break the wheel, or damage the work or the center; and, *never run a large wheel that has no guard over it.* Now to grind tapers on this machine, loosen the clamps at the end of the table and swing the table around in the proper direction by means of this adjusting screw. This end is graduated to indicate inches per foot, and you will notice that I have set it at ½ inch per foot, which is proper for a Brown & Sharpe taper. You cannot depend on these graduations, however, for more than an approximate setting. The shank should be ground enough so that it is nearly cleaned up and then tested with the gage, first wiping it clean and dry and putting a light chalk mark lengthwise of the shank; then when you try it into the gage and twist it around, if the chalk mark is rubbed off evenly and it seems to stick in the gage, it fits all right. If one end of the chalk line is rubbed off and the other is not it shows that the table should be adjusted to make the end on which the chalk was rubbed off a little smaller. You will note that the gage is marked "Tang to project ⅜ inch"; and when you have ground the shank small enough to let the end project ⅜ inch you have it the right size. You should watch when you are first starting to grind a mill to see if it runs out badly from being sprung in hardening, which frequently happens. When the work is not too badly sprung you can scrape the center in the shank over enough to get the mill to clean up all right, but if it is sprung too much for this, bring the part to me and I will have it hardened over again. When you have the shanks all ground you can grind the teeth on that little universal cutter grinder." And with that he left Jim to himself. He got along all right until he had the first one down nearly to size. As the wheel had not been dressed off, the work was rather rough. Jim noticed it but did not know what was the matter, though he could readily see that the finish was not as good as it was on lots of work he had seen. John Cary was working on a surface grinder nearby, and he asked him if there was not some way to make that machine grind smoother.



Figs. 1 to 4. Testing the Teeth of End Mills for Clearance

"Why! I should say that if the wheel were trued off it would do a better job," said John.

"How do you true it off?" asked Jim.

"Get a diamond from the tool-room and fasten it in the holder; then with the wheel running move it slowly past the diamond—you get the diamond and I'll show you how."

When Jim came back with the diamond John went over to the machine and looked the work over; then as he dressed the wheel off, he said, "I'll tell you how I manage when I have a lot of pieces that are alike, as you have here: I true the wheel off once when I begin the job; then I rough grind all of my work down nearly to size, leaving about 0.0015 stock for finishing. After that I true the wheel off again and finish one piece and note the reading on the dial of the feed handle. By bringing the handle to the same place for each shank you can get them all the same size without taking each one out to try it two or three times. You can also do this when you are roughing them out, only the wheel will wear off more in taking off so much stock and you will have to feed it in a little further each time. When you are roughing off work, it is almost impossible to do a job in reasonable time and have the wheel stay true, and you would have to dress the wheel on each piece to do a good job; but in roughing out, the wheel will stand some crowding and still be true enough to get the stock off rapidly. If you rough all the pieces first, when you come to finish them they will be round and clean, and as you have only one or two thousandths to take off each piece the wheel will easily stay in good shape to finish a dozen shanks. Use plenty of water at all times as it keeps the work cool and helps to keep the wheel clean."

"Thank you," said Jim, "I'll do it that way."

Jim got the shanks ground in reasonably good time, and in the meantime he watched a man that was sharpening some end mills in a machine like the one that Mr. Corbin had told him to use for that purpose, and he saw him take a mill out of the machine after he had ground two or three teeth and hold the mill up to the light with a scale across the teeth. Going over to him he asked him why he did that.

"I do that to see if I have the right clearance," said he.

Jim picked up a mill that he had not ground yet and held it up to the light, using his scale as a straightedge, as he had seen him do. "Oh," said Jim, "you grind the teeth at an angle with the face that will show clearance when the scale rests on the tooth following it." (See Fig. 1.)

"No! I don't! That gives too much clearance. Here try this one," he said, handing him one that he had just ground.

Jim held the scale on that and saw that it looked altogether different; in fact, it did not look to him as if it had any clearance at all.

"Why, on this one the scale does not even touch the following tooth. Surely, that is not clearance enough."

"Yes it is," said he. "As long as the distance from the cutting edge of the following tooth (*A*, Fig. 2) to the scale is less than the distance from the scale to the tooth in front (*B*, Fig. 2), you have clearance."

"But why was this mill ground like this?" said Jim, pointing to the mill he had first picked up.

"Some fellows have a wrong idea as to the amount of clearance needed, and that mill was not inspected after it was ground. It has altogether too much clearance; there is no support to the cutting edge, and the result is that it will get dull before it will do half the work it should. Let me take that flexible scale of yours and I will show you. There!" said he, now you can see the actual clearance it has when at work." (See Fig. 3.)

"Yes," said Jim, "that does look like too much."

"Now try the one here that I have just ground. See the difference? And there is plenty of clearance, too." (See Fig. 4.)

"I see that there is now, but at first I was inclined to think that you were joking with me. I have been sent for left-hand monkey wrenches, and to the blacksmith to get file teeth drawn out, and on other fools' errands, until now when I see or hear something that does not look just right at first, I am like the man from Missouri—I 'have to be shown.' Well, I have got these shanks about ground, and the next thing is to grind the teeth. I suppose that I will have to set that ma-

* Previous installments of this series of articles appeared in the numbers for August and December, 1909.

chine up as you have this one."

"No, I'll be through here in a few minutes and you can have this one. That one is all set up for grinding the teeth on the ends and I will finish my job in that. It will save us both work."

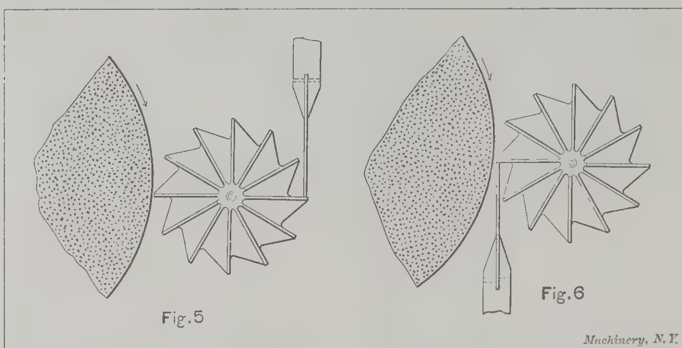
Jim wiped off the grinder and returned the gage and diamond to the tool-room and then started in to grind the teeth. As the machine was all set up he had no trouble at first, and he remarked to his friend on the other machine that "it was not such a very difficult job to grind cutters."

"No, the most important part is to get the clearance right and keep them straight. If they are not straight it is difficult to do accurate work with them."

"What is the best way to tell if they are straight?"

"Oh, just measure each end with your micrometer and keep them within a half a thousandth or so of the same size." Then as his job was finished he gathered up his work and tools and went away.

Jim got a two-inch micrometer and went over the mills he had ground and found that they were pretty straight. He



Figs. 5 and 6. Incorrect and Correct Methods of setting Tooth-rest

had only two more to grind the side teeth on, and one of them was the one that he had made the mistake on when he was milling it up. He put it in and started to grind it when he noticed that on one of the teeth the wheel did not cut at all, while it took a good cut off the others. He saw at once that something was wrong, and as John was still working on the surface grinder he took the mill to him and asked him what was the trouble. John looked at the mill and said, "Your machine is not properly set up."

"Why, it is just as that man who left a few minutes ago was using it, and he seemed to think it was all right."

"Well, I suppose it is all right for mills on which the teeth are evenly spaced, still I would rather have it set differently if I were using it, and not take any chances."

"What is wrong about it?"

"The finger which you use to index with should bear against the same tooth that you are grinding (See Fig. 6) and not on the opposite side, as it is now. (See Fig. 5.) With the finger, or stop, resting against the tooth you are grinding, all the teeth stand in the same position in relation to the wheel while they are being ground; while if it rests against any other tooth any inaccuracy in the spacing of the teeth makes an error in grinding. Of course, ordinarily the teeth of mills are properly indexed and it would make little difference, but you will occasionally find a case like the mill you have here, and also cases where the face of the teeth have been ground free hand, especially saws, etc., where it becomes necessary to grind new teeth because the old ones were worn too short to work good, and in such cases it is impossible to grind the mills or saws so that they will work good unless the tooth that is being ground is the one that rests on the index finger."

"I wonder why that man did not say something about that? He seemed to be a pretty good fellow."

"Probably he did not think that any of your mills had irregular spacing; or it may be that he never took notice of that feature. No one man knows all about this business, you know. We all have our failings and are never too old to learn something new to us and old to the other fellow. I have seen grinding machines put on the market by some of our most reputable machine builders, so designed that it was impossible to get the index finger underneath a cutter in the proper position. Still it is easy to demonstrate that it must be there to do good work."

Jim changed the machine by putting the arm that holds the finger into the binding socket from the bottom, then on re-grinding the mill he found that it acted differently. But on measuring the mill up with his micrometer he found that the tooth that was off in the indexing was apparently small, and he asked John the reason for that.

"That is all right," said John. "It is small because the two teeth you are measuring are not exactly opposite each other. If you had means of measuring the radius of each tooth, you would very likely find them all the same. If you doubt it, put the mill on the lathe centers, clamp an indicator in the tool-post and revolve the mill slowly by hand with the indicator just registering zero as the cutting edge of the tooth passes it and you will probably find that all of the teeth are of the same height."

"I think I understand what you mean," said Jim, and he went back to his machine and finished up his other mill, after which he called John over and asked him if the other machine was properly set up to grind the teeth on the ends. John looked it over and said, "I think it is, but we can tell better by putting a mill in and grinding it. There are two things to look after in grinding the teeth on the end of a mill. One is to get the proper clearance and the other is to be sure that the center of the mill is not higher than the outside. If the center is high it will not leave an even surface when at work; that is, if you were milling a plain surface on which it was necessary to take several cuts side by side you would find that the center of each cut would be low, leaving furrows on your work; while if the center was low this would not occur, so you see it would be better to have the center of a mill a little low, if anything."

"How do you tell when it is low?"

"By holding a straightedge across the two teeth that are opposite each other and noting that there is light underneath

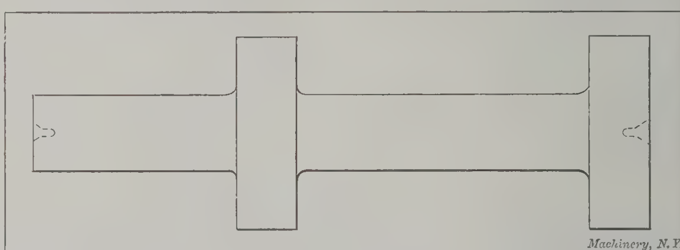


Fig. 7. Test Piece used to set Grinder Table Straight, prior to Internal Grinding

the straightedge in the center of the mill. Or, in case of an odd number of teeth, by rubbing the end of the mill on a plain surface on which you have rubbed a thin coat of prussian blue, then if the mill is properly ground the blue should show on the outer edges of the teeth and very little, if any, in the center. You very seldom find mills with an odd number of teeth, however, as it is difficult to measure the diameter of such mills, and unless it is necessary for some special purpose, they are not made. This machine seems to be all right, but a coarser wheel would be better, as this one is so fine that you are liable to burn the teeth if you are not careful."

"What do you mean by burning the teeth?"

"Why, drawing the temper from them. I don't suppose that it would be possible to burn steel in the way that it could be burned, or overheated, in a blacksmith's fire, by grinding. It is just an expression that machinists and toolmakers have coined for their own use and means heating the steel by grinding until its temper has been drawn. You will be able to notice it by the outer edge of the teeth turning blue."

"It seems queer to me," said Jim, "that this high-speed steel, which will remove chips of a blue color, could be injured by drawing the temper to a blue color."

"Well, to tell the truth, it does to me also, and I am unable to explain why it is so, but I do know that a great many brands of steel will not stand it. There are some brands of high-speed steel that the makers claim cannot be injured by heating on a grindstone or emery wheel, but I never saw any

that was improved by it, and I would much rather be on the safe side because steel on which the temper would not be affected will generally crack and check until the cutting edge would crumble away under a cut."

"But why is a coarse wheel less liable to heat a tool or cutter than a fine one?"

"A wheel for grinding metals is built up of numerous particles of abrasive material held together by a bond, or cement, and in a way could be likened to a milling cutter, as it actually cuts chips off, though, of course, they are very small and cannot be recognized as chips except under a strong magnifying glass. Now if you were to use a milling cutter with very fine teeth and force it to take all the cut it could, each tooth would cut until the space in front of it was full of metal when it could cut no more; then if it were not yet free to discharge this metal, or had not passed over its cut, it would have to carry the metal along rubbing hard against the work until it could get rid of it. By this time perhaps the metal is jammed in so hard that it sticks fast, and when the tooth comes around again it is already full and can only rub past the work, causing much more heat than it would if it could cut. On the other hand, take a coarse cutter and there is plenty of room for the chips, and each tooth can cut all the time that it is in contact with the work without crowding the space full of chips. It is the same way with emery, or abrasive, wheels; the coarse ones are adapted to remove metal fast without generating much heat, while the fine ones are more for putting a smooth finish on work, but they must not be crowded or the teeth will become full and the wheel will rub along instead of cutting freely."

Jim finished all the grinding on the mills and took them to Mr. Corbin, who looked them over and pronounced it a good job. "Now," said Mr. Corbin, "your surfacing mills are ready to be ground, and that will finish them. Take them over to the same machine that you used to grind the shanks on the end mills. You will find a chuck over there that will fit on the spindle of the head-stock; put that on instead of the driver, unlock the spindle so that it can turn, and shift the belt onto the pulley that is fixed to the spindle; then you can chuck the mills and grind the inside the same as you would bore them out in a lathe. There is an internal grinding attachment for the machine and you can get some one of the men that is working over there to show you how it is set up, as I have not the time now. I'll be over after a while and see how you are getting on."

Jim carried his work to the machine, put on the chuck and chucked one of the mills; then he asked John about the internal grinding attachment. John pointed it out to him, and told him that to put it on the machine he would have to remove the wheel from the main spindle and mount a pulley, which he showed him, in its stead; then turn the spindle head around and mount the attachment on the support provided for it and connect the spindle of the attachment to the main spindle by a belt. "Did you set the machine straight before you chucked your mill?" asked John

"No," said Jim.

"Well, you will find it a rather difficult job to get it straight unless you do it first."

"I don't know how to get it straight other than to set the graduations at zero."

"Here in this cupboard is a piece of steel that we use for that purpose. (See Fig. 7.) Take your mill out of the chuck and put this in instead, catching it by the small straight end; set it as true as you can and then take a cut off the two disks. When you have the table set so that your cut leaves both disks the same size, using a micrometer to measure with, the machine will be set to grind a straight hole. If you chuck the piece pretty true, you can get it nearly straight by noticing on which disk the wheel throws off the most sparks, and changing the table accordingly. Leave the big wheel on the spindle until you get the table set straight, as it will cut faster than the small one. When you are ready to put on the attachment, let me know and I will help you to get things right."

Jim got the machine straight in a short time and then removed the wheel and made the other changes that John had mentioned; then he called him over and asked him if he had things right.

"Yes, I think so," said John, "but you will have to get a new wheel, as that one is about worn out. Tell the stockkeeper that you want a wheel for internal work, if Mr. Corbin does not specify it on the order. You will probably have to turn it down with a diamond until it is small enough to go in the hole, as the wheels to fit this fixture do not come less than 1½ inch in diameter."

"How would you chuck the mills?" asked Jim; "true with the outside or inside?"

"True with the outside first; then watch when you start grinding and if the hole runs out so that there is danger of it not cleaning up, chuck it so that it will, leaving the outside as true as you can."

"But how can you tell that it is going to clean up before it is finished?"

"Well, until you get enough ground out so that you can measure the diameter of the hole, or until the cut covers more than half of the circumference in some one place, it is simply a matter of judgment; but after that it is a simple matter that is familiar to most lathe hands. Measure the diameter of the hole as the cut leaves it and subtract this size from the finished diameter; the difference is the amount of stock on both sides of the hole. Divide the difference by two and add the result to the size of the hole as it measures; set a pair of common inside calipers to this size, using an outside micrometer to set them to; then if there is no place in the hole that the inside calipers will not touch, the hole will clean up. For instance, suppose you grind out one of the holes so that you can measure the diameter of your cut, and then set a pair of inside calipers so that you can just feel a touch with both legs resting against a ground surface; then set an outside micrometer to the inside caliper so that you can get the same touch as you did in the hole, read the micrometer and find that you have ground the hole to, say, 1.242 inch diameter. The hole is to be 1.250 inch when finished; then $1.250 - 1.242 = 0.008$ inch stock still to be removed. $0.008 \div 2 = 0.004$; $1.242 + 0.004 = 1.246$. Set your outside micrometer to this size and set your inside calipers so that you get a light touch on the micrometer; then with the inside calipers measure the hole, and if you find no spot where the calipers are free, the hole will finish all right. You want to be careful though that the wheel is cutting full size when you take the cut that you measure from, for if it should spring away from its cut for a thousandth or so your measurements would be off. It is best to have apparently a couple of thousandths to come off the lowest spot; then you are sure. You will find that internal grinding is different from outside work, especially in small holes. It is necessarily a much slower job and cannot be crowded if you expect to do good work."

"Do you use water?" asked Jim.

"No. On outside work water washes the grindings away and helps to keep the wheel clean while the reverse is the case with inside work. However, it is a good idea to cool the work with water before trying in a plug or hardened and ground sizer; for if the work was warm and you inserted a cold sizer that would just go in, unless you were pretty quick in pulling it out again, it would be very likely to stick, as the hole would close in and the sizer expand, on coming in contact with each other."

Jim got on pretty well with his work and had a couple of the holes ground when Mr. Corbin came to see how he was getting on. "You seem to be going at it all right," said Mr. Corbin.

"The credit for that is due to Mr. Cary, there, who showed me how to go about it. Where will I grind the ends?" asked Jim.

"On this same machine. There is an expanding arbor that fits the spindle in the place of the center; put that in and loosen the nuts that clamp the headstock and swing it around so that the graduations read 90 degrees, and clamp it fast again. Then slip one of your mills on the arbor and secure it by tightening the screw in the end of the arbor; take off the internal attachment and put the big wheel back on the spindle, then you can back the wheel away until it will clear the mill, set the stops so that one reverses the travel of the

wheel at the center and the other at the outside. Let your cut come on the side of the mill that is traveling upward. The mills should be ground so that they are square across the ends, or if anything a very little concave. When you get the ends ground you can grind the teeth on the cutter grinder that you used to grind the end mills on." With that Mr. Corbin left Jim to himself again.

Jim got the holes all ground out and the machine set up to grind the ends. As he started in to grind, however, he found that the head was not set quite right to get the ends square, and he made several efforts at re-setting it without much better results. John noticed him and coming up said, "Leave the head clamped as it is and make any other adjustment you wish by changing the whole table the same as you would if you were grinding a taper. The screw adjustment on the table is much more sensitive and it is no trouble to move it as little as you like. You want to be sure and keep your wheel clean at all times so that it cuts and does not glaze the work by rubbing. Glazing seems to set up a strain in the metal; sometimes enough to burst the mill lengthwise. I broke two mills myself in this manner before I found out the cause; the tool hardener got the blame for it, and at the time I thought he was to blame, but I have learned since, from experience and observation, that it was my fault. I have seen several mills that broke during the grinding operation or shortly after, and all that I ever saw had a smooth glazed surface and under close examination would show numerous small checks all over the glazed part. I never like to see a smooth glassy surface on hardened and ground work unless it is obtained by lapping, and if such surfaces are afterward lapped they will generally show up more irregular than one obtained with a sharp wheel. In thin work such as saws, templets, etc., if the wheel is allowed to glaze, or even approach that condition, the work is sure to buckle."

"Is it much of a job to grind the spiral teeth on these mills?" asked Jim.

"No," said John, "it is an easy matter. The only difference in grinding straight and spiral teeth is that for spiral teeth the index finger is secured in a fixed position in front of the wheel; then when the mill is pushed by the wheel, the face of the tooth resting on the finger, which does not move, causes the mill to turn just the same as it did when the teeth were cut. The top of the finger should be rounded slightly so that the face of the tooth bears on the center of it. The wheel should be trued off so that that there is only a narrow cutting surface, and the finger should be wide enough to allow the tooth to rest on it before the wheel begins to cut, which should be when the end of the mill approaching the wheel reaches the highest portion of the rounded end of the finger.

"How do you hold the cutter?"

"You can either put in on a solid arbor between centers, or there is a hollow arbor for that machine with stepped collars to fit the standard sized holes in cutters; this arbor slides on a round bar that may be mounted in a fixed position in front of the wheel. This latter method is the best as there is no possibility of getting one end of the mill you are grinding smaller than the other, in fact, nothing but straight mills can be ground in this way. Well; I have got my job over here finished and I'll have to pick up and leave. If you run into anything you can't master, let me know and I'll do my best to help you out."

"Thanks," said Jim. "I think I ought to be able to finish up this job without bothering anyone any more."

* * *

As photographs are becoming more and more commonly used as evidence in legal cases, the *Engineering Record* calls attention to the necessity of having photographs thoroughly identified. Engineers and contractors who make a practice of taking photographs as matters of record would do well to have some independent representative present at the time each photograph is taken, so that he could go on the witness stand and testify that the views were taken in his presence and correctly represent the conditions on the dates when they were taken. Unless some such plan is followed the court may refuse to accept photographs as evidence on the ground that they are not properly authenticated.

TOOLS FOR DRAWING SEAMLESS AUTOMOBILE LAMP HOODS

WILLIAM A. PAINTER*

The drawing dies and punches for drawing a rectangular hood for automobile lamps, in one piece, are illustrated herewith. The advantage of a one-piece hood over the regulation built-up and riveted one is the convenience in cleaning, there being no seams or rivet heads to catch the rouge, cleaning compound or polishing cloth; in addition, the hood has more pleasing lines and greater accuracy can be obtained.

A rectangular shell or drawing is more difficult to produce than a circular one, especially where the corners or angles

Fig. 1. Punches and Dies for Rectangular Lamp-hoods and the Stock Before and After the Drawing Operations

have to be sharp, as the rapid flow of metal to the corners, when reducing from the flat, being out of proportion to the rest of the area, has a tendency to clog and tear the metal. This hood is made of brass, and measures 1 7/8 inch deep and 4¼ inches by 4½ inches across the sides; it is made from a round blank *A* (Fig. 1), the quantity not warranting a special blanking die attached to the drawing die.

The shell is drawn in two operations. Two dies of the same size are used, except that the drawing edges of the first die are rounded, while the second one is sharp. The cast iron shoes or holders are duplicates, and are made for a double-action press. The first drawing operation is made in die *D*, which is set in the holder in place of die *C*, which is the finishing die. The sleeve *B* is used in both operations. The

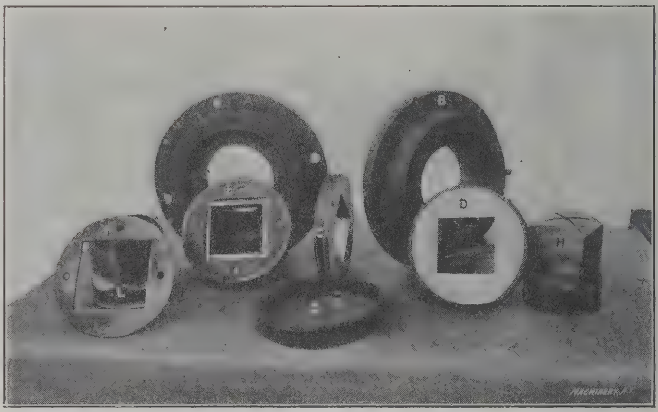


Fig. 2. Protective Shields used for Local Hardening and Dies with Shields in Place

blank *A* is held in place on die *D* by spring gage-pins, different holes being used for different depths of hoods. After the first operation, the flange on the shell is nearly rectangular in form, as shown at *G*. The flow of metal to the corners is also shown, proving that a circular blank is the correct shape, and not a rectangular one, as this shape would not draw at all.

The rounded punch *F* for the first operation and also the one shown at *E* for the second operation are both vented by holes and cross channels; the object of this is to prevent the punch from drawing the finished shell upward by suction on the return stroke of the press. The holes alone would not be of any advantage, as the sheet metal would cling to them and stop the passage of air, but with the channels this is overcome.

The first operation draws the shell to within 3/16 inch of

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full depth. The shells are then annealed, and the sharp draw-punch *E* and the die *C* are put in the press. The shell enters the die and rests on its flange, and is held by a sleeve while the punch enters. This operation sharpens the edges only, as the drawing of the metal has been accomplished in the first drawing die. The partly completed hood is shown at *H*, while different views of the finished hood are shown at *J* and *K*.

The dies and the sleeve are held in place by six half-inch square-head screws. The cast iron holders are bored straight to fit the dies, which are beveled five degrees in the center of the rim, leaving about 5/16 inch of straight surface at the top and bottom as shown at *C*, Fig. 2. This straight surface is an easy fit in holders *A* and *B* so that the dies can be revolved when the screws are loosened; the object of this is to permit first tightening the punch on the thread of the plunger when setting up tools, without regard to the relative positions of the die and sleeve. When a shell is put in the die and the bed is set to match the screws in the bolster, if the die is free it can be revolved until it matches the punch; the punch is then entered into it and all screws are tightened. This operation is repeated on the sleeve or pad, and it eliminates packing the punch with washers to make it line with the die, as well as the risk of the punch jarring loose and breaking the die or sleeve.

These dies were hardened by my local hardening process, as the shape and angles of the disks would make it a hazardous operation to harden them in the regular way. [For a description of this hardening process see Mr. Painter's article on Local Hardening and Tempering, August, 1908.—Editor.] The dies are 9½ inches in diameter, 1¼ inch thick, and only 1½ inch from the corners of the rectangular hole to the outside, so that the strain in hardening would be at these sharp corners.

The face of the die with one of the steel covers used in the local hardening process in place is shown at *D*. The back of another die when covered to within ½ inch of the square hole is shown at *E*. There are four ½-inch holes in this cover to equalize the cooling. The covers for die *C* are shown at *F* and *G*. These are the same as those shown in place at *D* and *E*. The thickness of the stock from which these covers are made is 0.025 inch. The band *G* is slit with shears and held together with rivets.

These dies were heated in a gas oven and then dipped in clear water. They did not shrink or warp, and have been used for drawing thousands of hoods. The punches *H* and *L* have machine steel bodies and tool steel working ends. The ends are hardened on the outside only, sheet steel being applied to the back of them when hardening. All these covers were put on before heating the parts and were dipped with them. The temper was drawn to a light straw color after the covers were removed.

* * *

At a recent exhibit of gas appliances in New York, certain power-driven machinery was shown, having exposed bevel and sprocket wheels in operation. To prevent accidents to visitors, they were protected with wooden shields, sufficiently to keep the inquisitive sightseer out of harm's way. In regular manufacturing use, however, we infer that these potential instruments of accident are absolutely unguarded, so far as the maker has provided. The extra cost of providing efficient gear guards would perhaps be two or three dollars at the most. What is the use of saving a few cents where the saving may mean the loss of a finger, hand or arm? Even if the humanitarian aspect is ignored, it is poor business policy of the user to let such man-traps exist, and he has a right to expect the manufacturer to supply his machines guarded in all respects where possible. Damage suits are ugly affairs; the defendant is beaten even if he wins because the ill-will and hatred engendered will cost him much in the end.

* * *

The value of the imports of machine tools to Hungary, according to recently published statistics, amounted in 1907 to about $900,000. Machines to a value of about $500,000 were imported from Austria, $325,000 from Germany, and only $58,000 from the United States. Recent developments show that Hungary offers a fair field for the machine tool trade.

YOUNG BRAINS AND OLD

A. S. ATKINSON*

It goes without saying that the young man has a better chance to-day than the old chap who has passed fifty, and when you get past the latter age, woe be unto you if you lose your job. It doesn't seem to matter very much that our grandfathers took more stock in age than in youth and looked upon the man under thirty as of little real account in the business and manufacturing world. Age meant maturity of judgment, and one couldn't be sure of himself much under fifty. So they put out their sign of "Slow and Sure."

Now we have reversed conditions, and every shop and business concern is picking up the young man and dropping the old. Of course some old codgers can't be shelved. They simply bob up smilingly and get there just the same. Nevertheless, the old sign has been reversed, and we read the warning, "Young men wanted; no old men need apply."

Well, of course, that's all right if everybody believes that a man of fifty has lost his usefulness and is chiefly good for holding down cheap jobs that an office boy fresh from school could do as well; but sometimes the "Oslerizing" process may be carried a bit too far. I suppose I am particularly interested in it because of the story about "Old Si Smith," which I related in a recent number of MACHINERY, and of another little experience of "Pop" Lester's, who took his medicine like a man and then got cured of the "old age delusion."

"Pop" was superintendent of the big machine shop whose sooty black smoke can be seen any day clouding the atmosphere up on the Hudson, just far enough beyond the city line to escape the Health Board's edict that nobody shall burn soft coal in the metropolis. This shop is one of the oldest in the country, and it had the reputation of doing some of the finest work on this side of the Atlantic. The old man who built it up had made Pop superintendent way back in the eighties, and under his wise management the profits had been large enough to please anybody except a modern millionaire's son anxious to get the record for fast spending.

Anyhow, when the old man died and the young chap inherited the fortune and the big machine shops, there was bound to be some sort of a change. The youngster came down to look the shops over, and brought an expert with him. They went through the shops, under the guidance of Pop Lester, the superintendent, and the way they commented on the machinery and equipment was enough to drive a good machinist crazy. "Antiquated," "Out of date," "Fit only for the scrap-heap." These were a few of the epithets they used, and Pop winced and bit his lips. He tried to explain that some of the machinery was almost as good as new, and that all of it was doing first-class work.

They didn't listen much to these apologies for the machines; they had a reason for their inspection. It didn't come out right away, but after a while it leaked. The young heir wanted to increase his profits, so he could spend a few more dollars on Delmonico dinners and chorus girls, and the machine expert was looking for a good fat job as superintendent and incidentally for some liberal commissions on machinery. They both had their way in time. Pop was kindly and thoughtfully relieved of his position, the young owner explaining plausibly that he wanted the shops run on modern methods, and he thought a young superintendent could do the trick better than an old man. His father had been all right in his day and time, but things had changed a good deal since he was a young man. The shops were in a bad way, and were not making half what they should. He had figures and facts to show it. Here they were, if Pop wished to examine them.

The old superintendent was too surprised and dumbfounded to protest or even to examine the paper shoved toward him. You see he had been the head of the shops so long that he had got into the habit of considering it a life job. It would have been, too, had the old man lived.

Pop wasn't exactly turned loose to shift for himself. That youngster condescendingly said that the deposed superintendent could take a position in the drafting-room, where he

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could make himself useful at twenty per week! Think of it!—when his salary had been running into figures that would pay for a first-class automobile once a year!

We felt sorry for the old man, every one of us, but we had too much to think about in holding down our own jobs without openly rebelling for the sake of another. Pop had been kind and considerate to every one of the boys, and we didn't forget it now. We went round in a delegation and asked him what we could do for him. Go on strike? "Good Lord, boys, no!" he said. "We never had a strike in these shops—not since I've been here—and I'm not going to be the cause of one. Go back to your work and hold your own jobs. I'm mighty thankful, however, for your expression of confidence in me—mighty thankful."

The new superintendent was about as boyish-looking as the young owner of the shops, but a little bit shrewder and more experienced. He knew more about machinery than his employer, and possibly more about men and business. At any rate it had all been framed up before he took hold, and the first thing they did was to rip out the old machines. Say, it was a waste of good material, and it gave you a real heartache to see the machines smashed up and carted away. Why, some of them weren't more than a year or two old, and some had done good service for five years and were good for five more. Some of Pop's old pet machines, a big jig-saw and a boring mill he'd had for ten years, were a little out of date and had been patched up some, but they hadn't lost five days for repairs or breakdown in all that time.

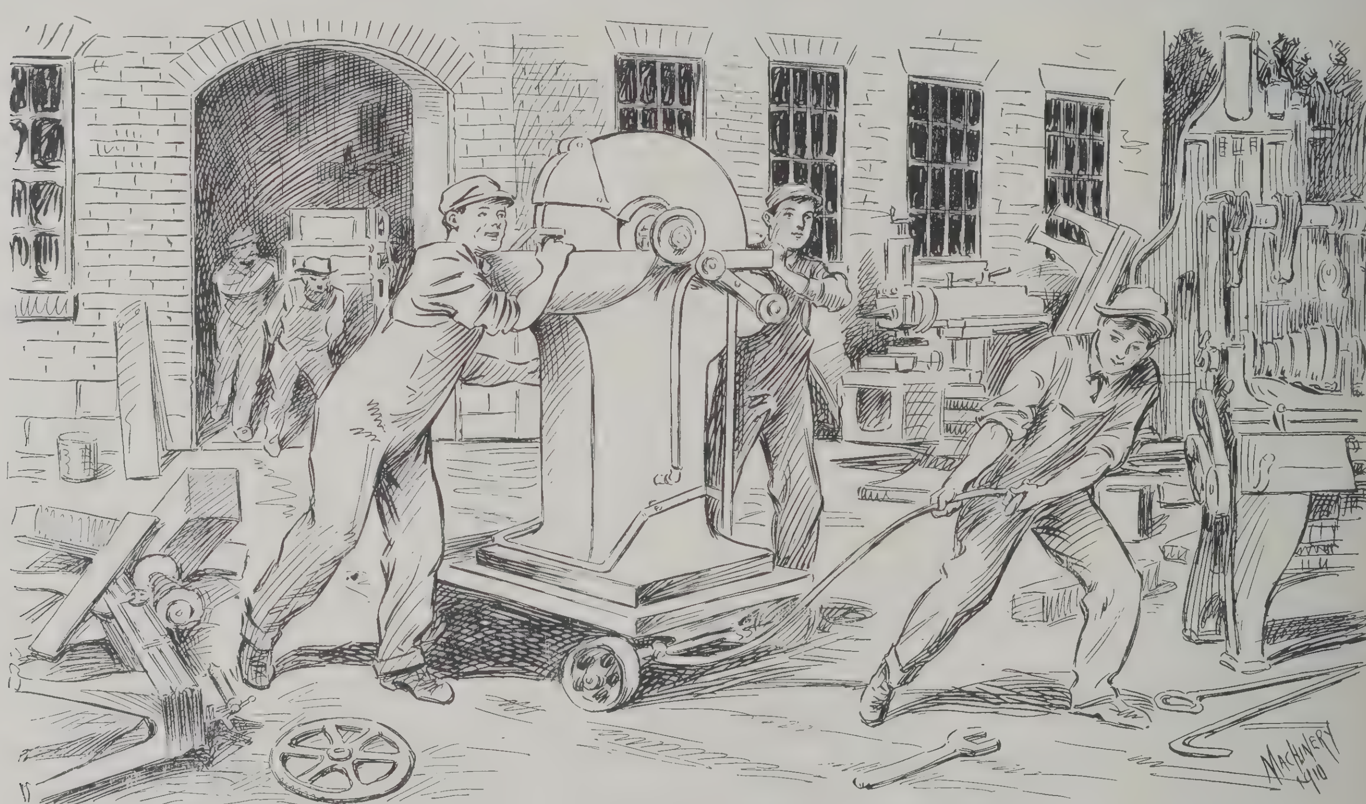
Pop had been a little economical in a way; he always hated to turn down an old machine for a new one until he was pretty well satisfied its days of usefulness were gone. I suppose he looked at 'em most as he looked at himself. A machine must wear out in time, and if you keep it long enough it will get out of date. But it isn't good policy to hurry it along to the scrap-heap too fast. Pop must have felt as if the bottom was tumbling out of everything when he saw those old and new machines ripped out of the shops and new ones put in. But he had nothing to say and the machines were sold for scrap and for second-hand machines, just as bidders chose. The new machines came in and were put up by experts. They looked all right, and were all right, and they had many new improvements. Some of 'em could do double the work, and I guess it was only a question of time before the young owner would find his profits increased. But we lost a lot of time making the change. Some of the orders ahead had to be cancelled, and others we lost through delay, so the contracting parties threatened to sue the young owner. There was a lot of legal quarreling, and a good deal of trouble all around. The young superintendent, I guess, hadn't figured on the loss of time the big change would make, and neither had the owner.

Well, things finally got started. We had a few new orders, and we started on them. But all that machinery was new to many of the men, and they had to go slow. The young superintendent told the foreman of the shops that he had to make up for lost time, and he tried to push us, but you can't be pushed when you're riding a new horse, and we had a lot of breakdowns and ruined much work. The more the foreman drove us, and the more the superintendent fumed and threatened, the worse we seemed to get, and the new machines showed they were nervous, too, or something like it.

Then pretty soon another trouble followed. Some of the work the shops turned out wasn't satisfactory and didn't come up to specifications, and the buyers refused to pay or threatened to sue the shops for swindling them. Now the old man had earned the reputation for superior work in the past, and his name stood for more than most people's bond. When an article came out of his shops and bore the name of the firm, it was accepted without question everywhere. This reputation meant a lot more to the shops than the young owner realized. At first he told the kickers to go to some hot place, and the others he defied in court and got all he wanted of such proceedings. I suppose he had to have the experience to cool him down and make him understand that even a millionaire isn't the only toad in the big business puddle.

Things went from bad to worse in this way, and by the time we got used to the new machines the shops had a dozen lawsuits on hand and a lot of rejected junk that buyers had shipped back to us. But worse than all this, we'd tarnished the reputation of the old man's shops for first-class work. I guess instead of increasing his income, the new superintendent had cut a pretty big hole in his employer's bank account.

We heard something about this from their talk around the shops, and they put their heads together to find some remedy. The first thing we knew about it was they'd decided to cut wages. That was something that had occurred only twice in the history of the works. Once when hard times hit the business world, the old owner had appealed to us, and said he'd have to cut wages for a time to prevent losses, but he'd restore them within six months or a year. This same thing



"Pop must have felt as if the bottom was tumbling out of everything when he saw those old and new machines ripped out of the shops and new ones put in"

happened ten years later, and each time we met the cut with a smile and assured the old man it was all right. He'd stood by us, and we'd stand by him. But now nothing was said about restoring the wages later. Indeed, when our committee spoke about it, they were pretty nearly kicked out of the office, and told to mind their business or they'd be "chucked" out body and soul. Pleasant, wasn't it? Just the sort of "dope" to make self-respecting workmen love their employer. We did, of course, and stood ready to grovel on the ground before him. We talked it over, and decided that for the present no strike would be called. We felt proud of the reputation of the shops, and didn't want to disgrace them. We stood it quietly for six months, and then we asked again if wages would be restored to their old standard pretty soon. We got our reply all right, and it was right in the face. It came in the form of another cut, and a pretty deep one. We couldn't stand for that, and we struck—every mother's son of us. We walked out and let the machines stand idle, and then the most distressed man around the diggings at that time was Pop Lester. He was genuinely sorry and worked up. He went around among us and begged us to refrain from any violence. He tried to excuse and apologize for the young owner and the new superintendent. But there wasn't much to say in their behalf, and Pop had some pretty weak arguments to present.

A big strike in a machine shop isn't an easy proposition for any employer to face, and that kid and his kid superintendent found before they were through they had to do some hustling. You can't pick up five hundred skilled workmen every day in the year, especially when the wages offered were small. So the strike drifted on for several months, and then to six months. The plant was losing orders right along, and it was costing the owner a pile. I guess he had to cut out some of his expensive dinners and chorus girls.

It was the most peaceful strike I ever saw. Pop was around night and day, and we listened to his advice and kept from doing any harm. They managed to get a dozen or two men in the shops, but they ruined more work and machines than anything else. Then one day Pop Lester came around with a more serious look on his face than ever, and when he got enough of us together, he said: "Boys, I want you to go back to work to-morrow—for my sake."

"Too much to ask, Pop," somebody yells out. Then another says: "If you'll be superintendent of the shops, we'll go back at the old wages."

The old man smiled and answered: "That's just what I came to tell you. I've got back my old job, and I want every man here to get his, too."

There were plenty of wild cheers then, and some of them were so noisy that we had to wait a long time for the old superintendent to finish. "You will have to go back at the lower wages," he continued, "for the plant has lost lots of money, but as soon as we get some of it back, we'll restore wages."

Did we go back? You bet! The next morning every man was in his place, and things began to hum. Pop was kept as superintendent after that until he died; and as for that youngster, he learned his lesson, and now before making a big change he always consults with his old reliable guards.

* * *

The use of lava for gas burner tips dates from 1854 when J. von Schwarz discovered its advantages for the purpose. The lava is found in Bavaria at the southeastern point of the Fichtel Mountains, near Bayreuth. It has been used for hundreds of years for musket balls, marbles, fireproof utensils, carved ornaments, etc., being readily turned, sawed and polished. It does not disintegrate with long-continued and repeated heatings, and its smooth non-porous surface prevents carbonization and deposits from the gas.

* * *

The value of the yearly import of machine tools to Spain amounts to about $600,000, and Germany supplies more than one-third of the machine tools imported. Apparently Spain offers an opportunity for the increase of the foreign trade of the United States in machine tools.

JIGS IN A REPAIR SHOP*

A. H. LAVERS†

That jigs are an indispensable factor in economical quantity manufacturing is undisputed. As a necessary element in repair machine shops that are a part of any manufacturing establishment, where the shop is used merely in repairing and building additional equipment, the use of jigs has apparently been neglected to a greater or less extent. This applies particularly to plants in which repairs must be interchangeable and effected at short notice.

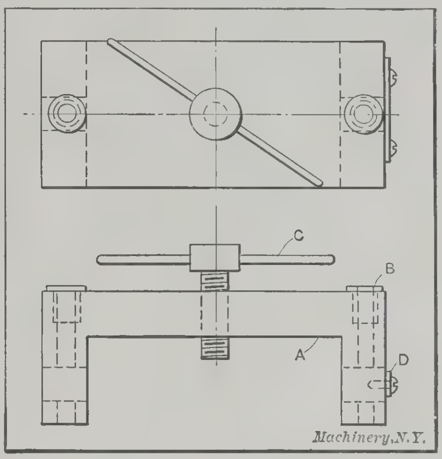


Fig. 1. Simple Form of Jig for Drilling Two Holes in Shaft Ends

In the case of pipe flanges and fittings, or standard parts, it pays to make up fairly expensive jigs, as a standard once established can rarely be altered without causing confusion. The cost of jigs for parts of machinery constantly undergoing changes and improvements, is usually the most important feature, although the time element in duplicating parts must not be lost sight of. Another point that undoubtedly has a bearing on the question is to make the jigs as simple and fool-proof as possible, thereby permitting the employment of unskilled labor in drilling operations and minor lathe jobs.

As a usual thing, repair shops of this character are supplied with drawings of a machine and an order to build one, which, if satisfactory, would necessitate the building of several more. At once the question presents itself: If the machine is satisfactory, what parts will wear out, call for replacement and the use of jigs in repair? This must be decided and then the simplest possible design of a satisfactory jig should be made.

It is good practice to leave the judgment of matters of this kind to some one man who is familiar with the particular shop's practice, but entirely independent, and who, also, has an opportunity to study the machines in operation in both the machine shop and the factory.

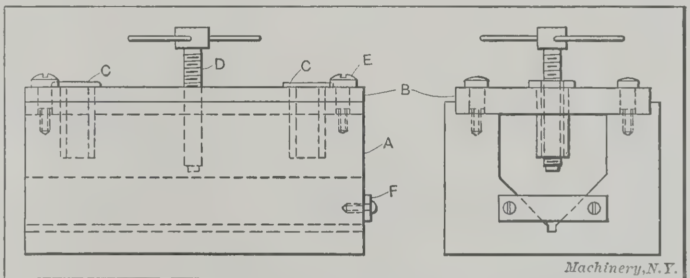


Fig. 2. Jig with Removable Top and V-shaped Locating Surfaces, for Drilling Shaft Ends

A great help in production of work of this kind is to have an equipment of reference gages for press, running fits, etc., standard reamers and tram-rods for bores or parts of large diameters. It sometimes helps to economize by combining several operations on different machines in one jig, and further on some illustrations of this will be presented. Once in a while a job will present itself in which the first number of duplicate parts required will run up in the hundreds, and then a dozen pieces that are duplicates are required at frequent intervals. This, of course, allows the expenditure of a little more money to decrease the first cost of

* For additional information on this subject, see the series of articles on Jigs and Fixtures which began in April, 1908, and other articles referred to in connection with the first installment of this series.
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production, thereby giving a little better price to succeeding pieces.

The writer will, in the following illustrations, endeavor to present a number of simple jigs covering various operations. It is not claimed that there is anything strikingly original about these jigs, but simply the adaptation of simple means to produce interchangeable work. It is also intended to include in this article some examples of simple lathe and boring mill chucks, which, while they are not, properly speaking, jigs, are an important aid to the production of interchangeable parts.

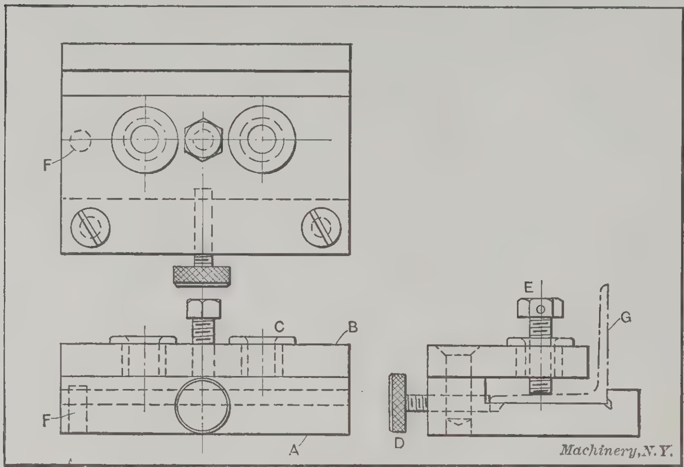
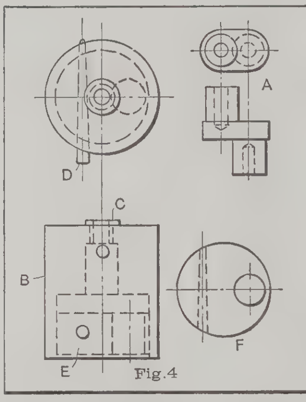


Fig. 3. Simple Jig for Drilling Accurately-spaced Holes in Angle-iron



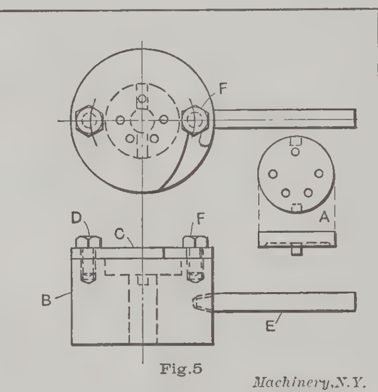


Fig. 4. Ingenious Form of Jig for Drilling Crank A

Fig. 5. Jig with Hardened Plate which guides the Drill and clamps the Work

The jig illustrated in Fig. 1 is for drilling two holes at the ends of a piece of shaft, and, as may be seen from the illustration, it is of the simplest construction. The body *A* is of U-section and in it holes are drilled to receive the work. Two holes are drilled at right angles to the shaft openings, and are counterbored to receive the bushings *B*. The shaft is clamped by screw *C*, and located by stop *D*. It may be worth mentioning that the body was made of an old casting which happened to be available, and the same thing is true of several of the other jigs illustrated. It is a distinct advantage to use patterns of machine parts to make jigs of, if possible, and in a fairly large plant with a variety of machines, the number of patterns that are available for such purposes is surprising.

Fig. 2 is a sketch of a jig that was made to accomplish a purpose similar to that of Fig. 1, but it has an advantage that will be noted. The surface against which the work is clamped is V-shaped, and the body *A* is provided with a removable top plate *B* in which the drill bushings *C* are located. This plate may be taken off and another one substituted with a different size and spacing of drill bushings, thus making the jig available for one or more jobs. In this particular case, it was possible, by this method, to use this jig for over twenty-five similar pieces of work. The fitted screws *E*, locate the various plates *B*, while *F* serves as a stop for the work.

The writer is aware that there are various simple adjustable center distance jigs that could be devised, but his experience has been that it is rarely possible to produce duplicate work economically with unskilled labor when using such jigs. It is almost impossible, without the use of precision measuring tools, to adjust a jig twice alike, whereas by the use of the plate *B* in Fig 2, an error made in the plate is not increased in the work, measuring is avoided and there is not the possibility of having the errors one way one time and another way the next.

In Fig. 3, we have another extremely simple jig that serves its purpose excellently. It is used to drill an angle iron in which the holes must be accurately spaced. *A* is the body, *B* is the cover containing the drill bushing *C* and the clamping screw *E*, and *D* is also a clamping screw with a knurled head. The angle iron *G* is placed against stop-pin *F* preparatory to clamping.

In Fig. 4, the extreme simplicity of this jig is its principal charm. It is used to drill a hole in each end of the lubricator crank *A*. The drill bushing *C* is centrally located at the top of body *B*. Beneath this bushing there is an enlarged hole to accommodate one leg of the crank. The other leg is placed in the piece *E*, which is shown in plan at *F*. This piece *E* is held in place by the dowel-pin *D* and it is a neat sliding fit in body *B*. The hole drilled in the body just under the bushing *C* is to allow the chips to escape. Incidentally, it should be noted that this jig represents about three hours' time for its construction; it paid for itself on its first job.

A jig is shown in Fig. 5 that is built on a different principle. It was designed to drill the pneumatic valve shown at *A*, which is a disk having five 1/8 inch eccentric holes and two lugs. It is finished on one face, on the side, and on the small surface shown on the other face. To drill the disk, it is placed in body *B* which is counterbored to fit it and which has corresponding recesses to receive the lugs. The cover *C*, which is hardened, acts both as a series of bushings and as a clamp. This cover is rotated on the screw *D* to permit the removal and replacement of work. The opposite screw *F* clamps the cover securely in position after the work is in place. A half-inch pipe handle *E* is provided simply for the operator's convenience.

As noted in the first part of the article, some jobs call for a considerable number of duplicate parts and permit the construction of a more complicated jig. This is illustrated by Fig. 6. The requirements call for four holes of different sizes to be accurately drilled in a machine steel link. This is a fixture with an eccentric clamping device of original features. *A* is the body; *B* the cover; *C* are the smaller drill bushings, and *D* the larger ones. There are three stop-pins *E*, which are light press fits in both cover and body. There are three eccentric clamping disks *F*, *G*, and *H* (see also enlarged detail). Disk *F* rotates on *G*, and *G* on *H*. An extension on *F* rotates in the body *A*, and the larger extension

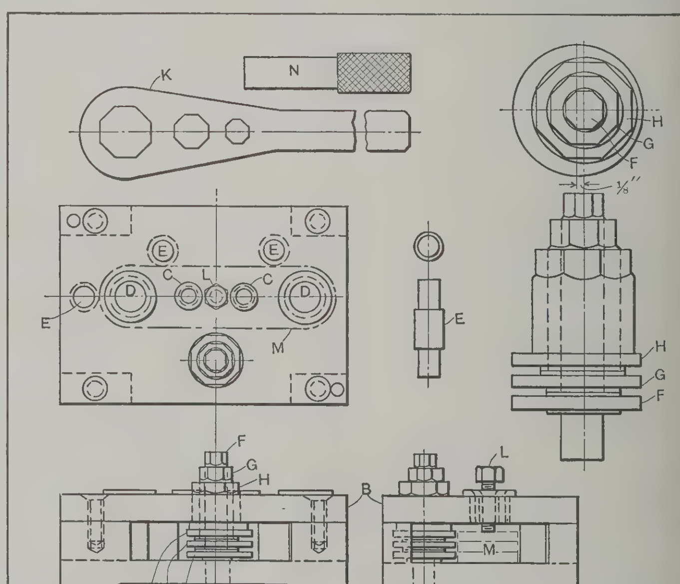


Fig. 6. Jig equipped with Unique Type of Eccentric Clamping Device

of *H* in the cover *B*. There is an octagon on the end of each disk spindle, and a wrench *K* with corresponding holes to fit each. The links *M* to be drilled are shown in position, three being drilled at one time. This arrangement of eccentrics gives an independent side clamp for each link, thus allowing for any irregularity in width. The clamping screw *L* has an octagon head to fit the smallest hole in wrench *K*. A plug *N* is placed in the first of the larger holes drilled, to prevent the pieces from working when drilling the other holes, although the work has been satisfactorily done without it.

In Fig. 7 there is shown a casing for a reversing mechanism and in Figs. 8 and 9 two jigs, the former being a boring mill jig, and the latter a drill jig for drilling the flange holes in line with the bearings. The casing is composed of three parts: *A*, *B*, and *C*. As will be noted, this casing has four bearings in it, two of different sizes in *A*, one in *B* of the same size and in line with the smaller bearing in *A*, and one in *C*, in line with, and the same diameter as, the larger bearing in *A*. The holes at *X* and *Y* are for fitted bolts, used instead of dowel pins, and the other ten holes shown are clear-

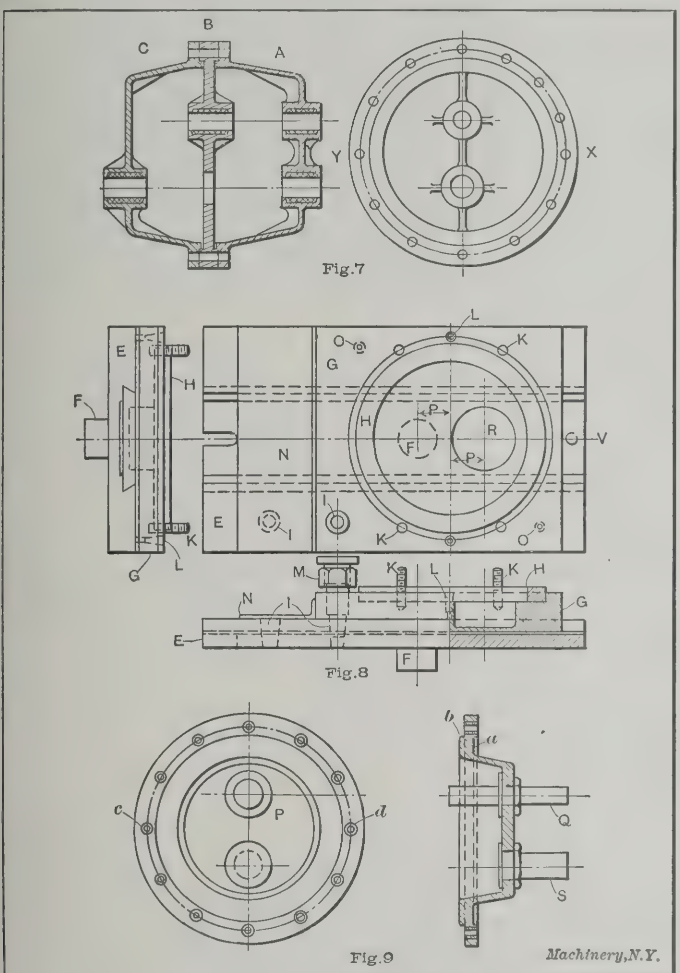


Fig. 7. Casing with Drilled Flanges and Bored Bearings. Fig. 8. Jig in which Bearings are bored. Fig. 9. Jig in which Flanges are drilled

ance holes for through bolts. As will be shown later, the fitted holes serve a double purpose. The casings are made male and female at the joints, and these are turned to close limits, *A* and *C* being alike, and *B* fitting into them.

In order to properly set forth the features embodied in these designs, it will be necessary to describe the boring mill jig, then the drill jig, and afterward give a short description of the operations. In Fig. 8 *E* represents the body of the boring mill jig, in which there is a tapered slide on the top side, and a pin *F* on the other side to fit the hole in the table of the boring mill, thereby centering the body *E*. The slide *G* works in and is closely fitted to *E*. This slide is counterbored to fit the male part of the joint in casings *A* and *C* on the longitudinal center line and midway between the bearings in the casings. The removable ring *H* is closely fitted to *G* and projects just enough above *G* to fit the female joint on part *B*. By removing *H*, *G* becomes the opposite of the joint on *A* and *C*.

Two tapered holes *I* have a center-to-center distance equal to that of the bearings in the casings. Four removal studs *K* are made somewhat smaller than the bolt holes in the flanges of the casings to hold the latter in position after they are located in the jig. There is a tapered hole *L* on each side of *G*, and these serve to center the casings and always bring the bearings in the same relative position. The pins are parallel and closely fitted where they go through the casings, and

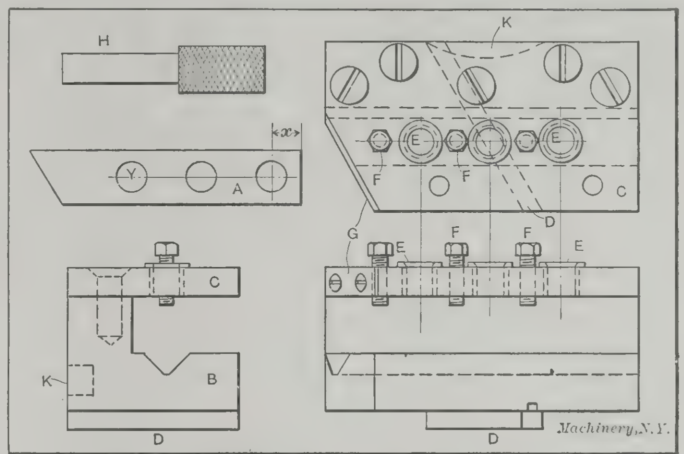


Fig. 10. Combined Drilling and Milling Jig for Part A

tapered below that to fit the holes *L*. A tapered pin *M* fits holes *I*, and is parallel where it goes through *G*. The nut shown is for the purpose of releasing it; the head is simply a projection to allow *M* to be securely driven into *G*. The locating pin that fits the tapered hole *L*, and also the reamed holes *X* and *Y* (see Fig. 7) in the casings, is similar in construction to *M*, but smaller. A protection strip *N* prevents chips from getting into hole *I*, and the working part of the slide *E*. *R* is simply a clearance hole in *G* for the bearings.

In the drill jig shown in Fig. 9, the casing *P* is the principal part. This casing is recessed at *a* to correspond to the male part of the joint on casing *A* and *C* and at *b* to fit *B*. The pin *Q* on the inside of the jig fits the bearing in *B*, and on the outside the small bearing in *A*, while *S* fits the large bearing in *A* or *C*. When drilling *C*, pin *Q* is removed. There are twelve holes with bushings shown; the two at *c* and *d* are removable to allow smaller bushings to be inserted, in order to first drill and then ream these two holes for the fitted

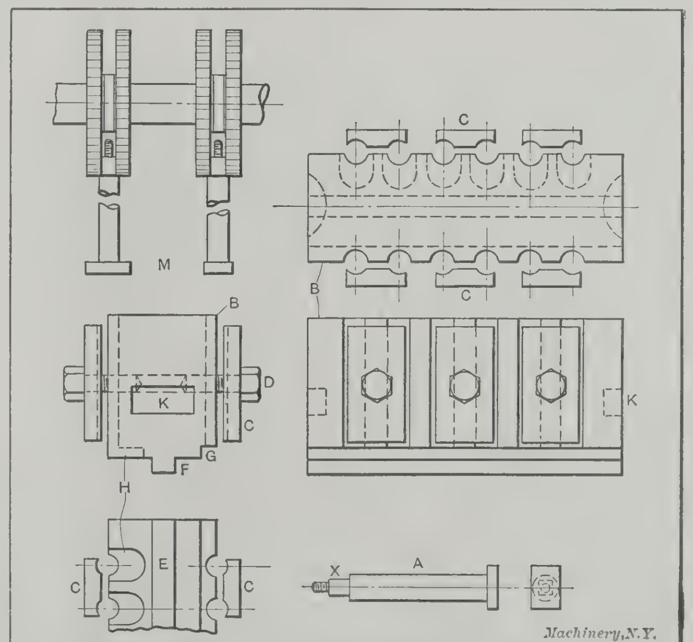


Fig. 11. Fixture for Milling Square X on Bolts A in Correct Relation with Rectangular Heads

bolts previously referred to. A brief description of the boring and drilling operations will make clear some of the uses of various parts of these two jigs.

When machining a new set of casings, the studs *K* are removed from the boring mill jig, and placed in the tapped

holes O, and the ring H is also removed. The casings A and C are first finished on the faces of the flange and tongue, and the bearings rough babbitted. Either casing A or C, as the case may be, is then placed in the boring jig, and the bearings approximately lined up with the center line V. The casing is then clamped on the jig by means of U-clamps placed over the studs K in the tapped holes O. The bearings are then bored; first the one in line with F, and then the other, after the slide is shifted to the next location by inserting pin M in the other hole I. The drilling jig is now placed on the casing and pins Q and S are inserted in the bearings, thus locating the holes in the flange with reference to the bearings. All the flanged holes are drilled and holes X and Y are reamed. In case of repair to the bearings, the casing A or C is located on the boring jig by the pins that fit into the reamed holes X and Y, and in the tapered holes L in the slide G; the casing is then clamped by means of studs and nuts K in position in the boring mill jig. Thus one jig is dependent on the other. When casing B is to be bored, the ring H is placed in the position shown in Fig. 8, and then the operation is the same as described for A and C. By the use of these jigs, it is possible to produce new work or repair the bearings in the old casings at any time, and they will be interchangeable. The bearings are, of course, bored to gage.

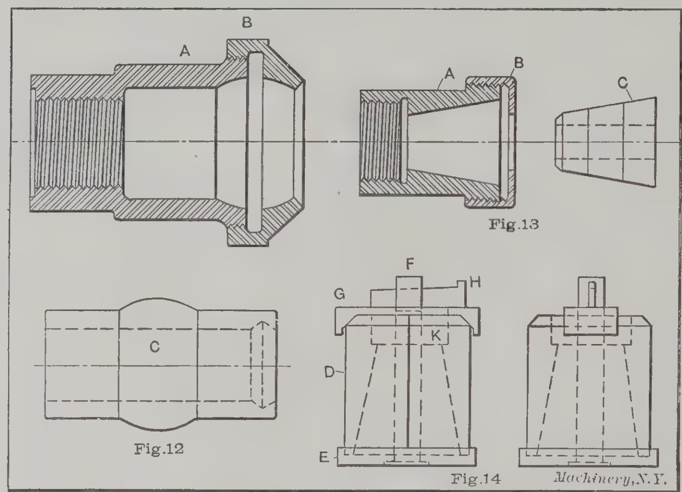


Fig. 12. Simple Chuck in which Bearing C is bored. Fig. 13. Chuck for Boring Part C. Fig. 14. Babbitting Jig in which Part C is cast

In Fig. 10 we have an example of a combined milling and drilling jig. The work A consists of a round piece of tool steel, one end of which is to be milled at an angle and accurately spaced from the center lines of three holes to be drilled; the distance x on the work is immaterial within 1/8 inch. B is the body of the jig, having a V-slot cut in it to center the work, and a recess K in the back to clamp it to the table of the machine. A clamp on the other side rests on the jig near the V-groove. In the top-plate C the drill bushings E, and the clamping screws F are located. A removable piece D is recessed into B and made to fit the table slots in the milling machine, thus setting the work at the proper angle; during the drilling operation this piece is removed. The milling cutters are set against a hardened strip G to secure the proper distance from the center line of the first hole and the angle of the cut. After the stock is cut off with a power hack-saw it is clamped in the jig a certain distance from the last hole in the end; this distance is equal to X with an allowable variation of one-eighth inch. The hole Y is first drilled, and then the plug H is inserted to prevent the work from moving. The other holes are then drilled. After the required number of pieces are drilled, the piece D is fastened to the fixture, which is clamped to the milling machine table. The end of A is then milled, plug H locating the holes with reference to the cut.

Fig. 11 shows a milling fixture in which the work A is milled square at X, and at a certain relation to the rectangular head. The body of the fixture is recessed on its sides to a depth equal to half the diameter of the bolt. It is also recessed on the bottom at H to correspond to the longer side of the rectangular head, and at G to fit the shorter side. This is shown plainly at E. The bolts are held by clamps C and clamping screws D. A projection F fits the table of the milling machine. Recesses K on each end of B are used to clamp the fixture to the table. The first and second settings of the bolts are clearly shown by the diagrammatical view at M, making further explanation unnecessary.

A simple chuck is illustrated in Fig. 12 for boring the bearing C. This bearing is first turned all over on the outside by a forming tool and then mounted in the chuck. The body of the chuck A is threaded on one end to fit the spindle of a 16-inch lathe, and it is bored out on the other end to fit the parallel end of C. B is a cap screwed onto A and bored to fit the spherical part of C. Thus when C is placed in chuck A and cap B screwed home, it clamps the work on the spherical part; the parallel part is also effective in centering the work. This chuck is extremely simple, yet very efficient.

The chuck shown in Fig. 13 is similar to that in Fig. 12, except that the work is tapered, C being the work, A the body of the chuck threaded to fit a 16-inch lathe, and B the clamping cap. As the work, in this instance, is of composition, the babbitting jig used will be of interest and is illustrated in Fig. 14. The base E is counterbored on the under side to receive the head of pin F, and on the top to fit shell D. This shell is split through the center and tapered at the top to correspond to the taper on G. Pin F, which acts as a core, is slightly tapered, and has a slot in the top so that by driving the key H in, G, D and E are securely clamped together, making a solid box. By removing H, the box falls apart and F is easily driven out of the work A. The parallel part K of the top is to allow chucking in the lathe for forming.

In summing up, the important points to be observed in repair shop jig design, are: (1) Simplicity; (2) minimum cost; (3) ease of operation consistent with cost; (4) use of machine parts or patterns already made, in designing fixtures, when only slight modifications are necessary; (5) the co-operation of the machine designer to secure simplicity in parts; that is, a number of simple pieces in preference to one complicated piece of mechanism, thus helping the shop side of the question; (6) the combination of a number of different machine operations in one fixture, if this can be done at a minimum cost, as a small loss of time on the machines, due to changing, is not noticeable in comparison to a high fixture cost for a few pieces of work; (7) comparative interchangeability; that is, good enough for the intended work but no more, as going to extremes in this line of work is particularly objectionable.

* * *

It appears that Australia intends to take a prominent place in the development of aerial navigation. A consular report states that Messrs. Walter Thompson and F. A. Boyd of Perth, West Australia, have developed certain designs and models for aerial navigation machines, including, among other inventions, a novel steering apparatus, a "fulcrum" by which an aeroplane floating and soaring in the air will maintain a condition of perfect equilibrium, and a simple and safe design, making it possible to attain speeds with aeroplanes higher than those hitherto attempted. A company has been formed in Australia, and a member of this company has left for England in order to exploit the inventions there. With no other details than those above at hand, it is, of course, impossible to say whether or not the inventions are of practical value and importance.

* * *

Perhaps there is no other feature of marine architecture about which there is so much doubt as the propeller, nor any feature more important to-day in the matter of efficient propulsion. An excellent illustration is the recent improvement made in the Cunard steamship *Mauretania*, by the change in her low-pressure propellers from three blades to four blades. They were made with other changes in design in accordance with a formula deduced by one who made a special study of the subject. The increase in speed is remarkable considering that the *Mauretania* had already exceeded the limit imposed by the contract of the Cunard Co. with the British government.

NEW SPUR GEAR GENERATING MACHINE

JOSEPH G. HORNER*

A new spur gear generating machine (the Sunderland patent) is being manufactured by Messrs. J. Parkinson & Sons, of Shipley, Yorkshire, England. There are several bevel gear generators in the field, but few as yet for spur gears, the reason being that the objections to the use of single rotary cutters are not so great when spur gears are cut as when they are applied to bevel gears. Still, the growing demands for teeth of ideal accuracy for high-speed gears includes spur teeth, and the use of the single rotary cutter introduces elements of slight inaccuracy which are inconsistent with the ideal. The Fellows' machine has been familiar for many years, but the greatest impetus to generated spur gear teeth was given about three years ago when German designs of machines for generating these gears by hobbing were introduced. This lead has been followed extensively in England and the United States. The Sunderland spur gear generating machine is designed to avoid the difficulties which have arisen in the operation of the hobbing machines. These were principally the cost of hobs, which is high, due to the difficulties in hardening and grinding them, and to the heat generated in heavy cutting, which results in inaccurate gears. In the Sunderland machine a rack-shaped cutter is employed, containing six teeth hardened and ground. Its cost is only about one-fifth that of a hob, it is easily re-sharpened, and less heat is generated in cutting, while increased output is claimed.

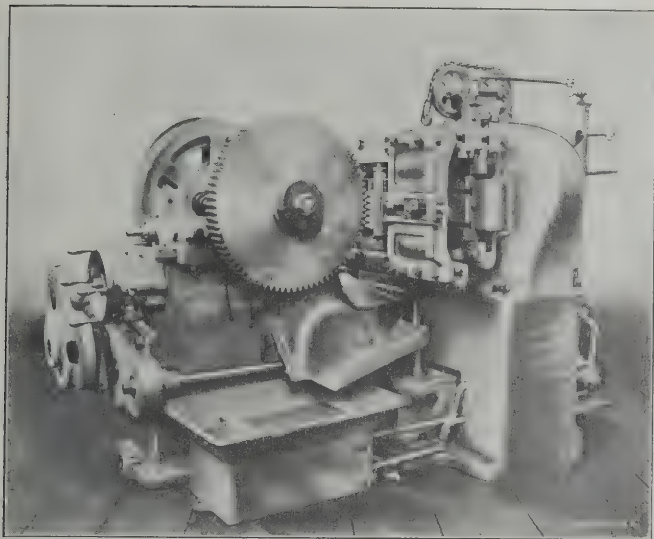


Fig. 1. The Sunderland Patent Spur Gear Generating Machine

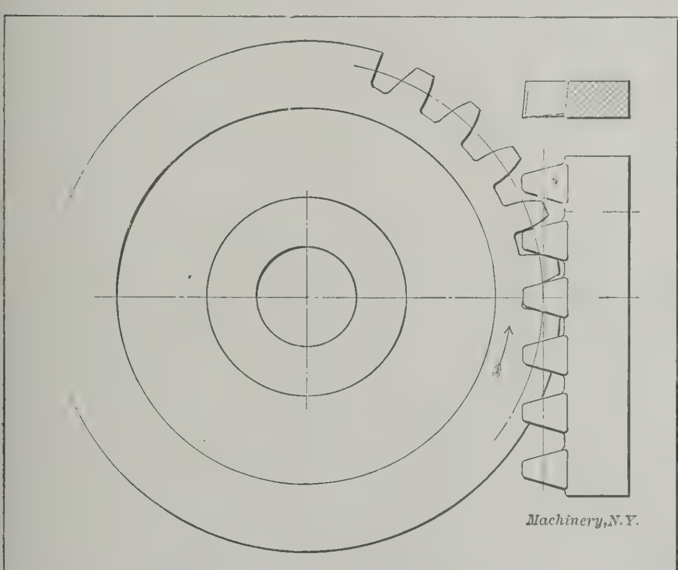


Fig. 2. Diagram Showing Action of Rack-cutter in the Sunderland Gear-cutting Machine

The rack cutter, of involute type cuts, of course, all gears of the same pitch, all meshing accurately with each other and with a rack; and the results are more accurate than those obtained by single rotary cutters, or by planers controlled by a former, while one cutter only is required for one pitch instead of a series of rotary cutters, or a series of formers. The rack cutter is mounted on a slide which imparts a reciprocating motion to it, while the wheel blank, mounted on a horizontal arbor fitted in the spindle of the dividing wheel, rotates in relation to it, in unison with an upward movement of the cutter slide, as in the actual engagement of gears. The rolling movements impart the tooth curves while the reciprocating movements of the rack tool out the teeth to the correct depth. Several of these operations repeated are required to complete the teeth of the wheel. In the first position the cutter touches the edge of the blank. In the second the blank is fed in to the proper depth, while the spaces are cut by the reciprocating cutter. The heaviest work is done by the leading teeth of the cutter, and as the wheel blank rotates in unison with the upward movement of the cutter the remaining teeth are gradually relieved from strain, and thus retain their keen cutting edges longer for finishing. After as many teeth are cut as can make full contact with the rack cutter through a distance equal to one pitch, the wheel blank is withdrawn clear of the cutter, its rotary motion arrested, and the cutter-slide returns vertically to its original position, that is, to a distance equal to the pitch being cut. The blank is then returned forward to the position for cutting, the rotary motion is re-started simultaneously with the upward movement of the cutter-slide, and another cutting cycle repeated. These movements are automatic until the wheel is completed. Only two sets of change-gears have been set up, one for the number of teeth to be cut, and the other for the pitch. Cutting speeds can be varied from about 20 feet to 40 feet per minute. The various speeds are obtained in the machine itself, so that the machine is driven by a constant-speed belt from a line-shaft; or it can be arranged for a motor drive. A pump and circulating pipes are fitted to the machine.

Fig. 3. First Position: Cutter just Touching Blank

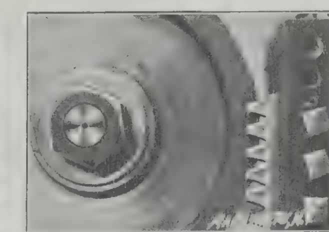


Fig. 4. Second Position: Blank Fed to Proper Depth for Teeth

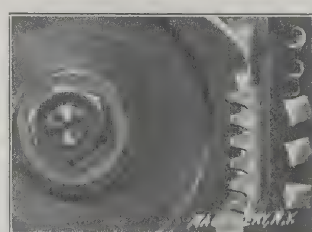


Fig. 5. Third Position: Blank and Cutter having Advanced a Distance equal to the Circular Pitch

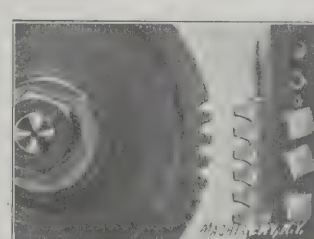


Fig. 6. Fourth Position: Blank withdrawn from the Cutter

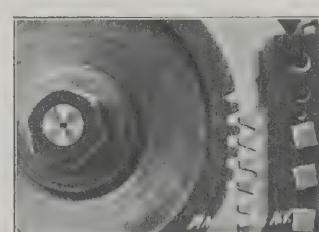


Fig. 7. Fifth Position: Cutter returned to Starting Point

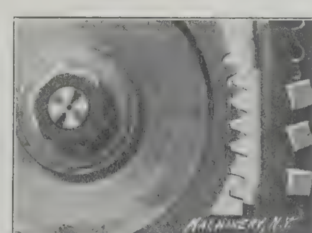


Fig. 8. Sixth Position: Blank returned to Cutting Position; beginning of Second Cycle

The machine cuts gears from 3 inches to 24 inches in diameter, and pitches from 8 to 2½ diametral pitch, and widths of faces up to 8½ inches. It weighs 3½ tons.

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MACHINERY

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

FEBRUARY, 1910

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

GROWTH FROM SMALL BEGINNINGS

The machine tool industry is remarkable in the fact that it is a growth from small beginnings. In mentally reviewing the history of the firms which have been successful in that line, we do not call to mind one which made a flying start with large capital and highly developed organization behind it. These phases have come later. The original start was made from humble beginnings, often by men working at the lathe and the bench.

This hopeful condition is due, possibly, to the high plane of development which machine tool design has reached in this country. The plane is so high that the product which is to meet competition successfully must have behind it a *personality*, brimming with enthusiasm and original ideas. Such personalities are self-selective. They rise to the top like the cream in the milk pitcher. They are not usually attracted by complex organization and powerful resources.

* * *

A DEFECT IN THE SALES DEPARTMENT

Almost every enquiry a manufacturer receives has some value—the actual value depending largely on the way the enquiry is handled. Comparatively few advertisers so handle their enquiries as to get the greatest possible return from them. Some are content with sending a catalogue or circular, and possibly a form letter, which they never follow up, although in many cases a purchase is not made for months after the enquiry is sent in. Other manufacturers, particularly of automobile supplies and office appliances, it is positively dangerous to write to, because the name of the enquirer is immediately placed in a species of mill which proceeds to grind out long follow-up letters, the intent of which is apparently to make life a burden for the unfortunate enquirer, and in time to force him to buy. There must be a reasonable mean between these two methods, and it can be found in the intelligent handling of enquiries by a trained office man who thoroughly understands his business, and not by a typewriter who is handed a list of names to send form letters to.

If the manufacturer considers the amount of money which is often spent in trying to effect a sale, he can quickly figure out that it will pay to handle enquiries intelligently. An instance of the lack of this quality is mentioned by a well-known machine tool dealer who writes us:

> A manufacturer will send us prices and quote us discounts, and we take an order and send it in. In the meantime he has made some exclusive agency arrangements with another house covering this territory, and we are politely informed on receipt of the order that they can't fill it on account of these arrangements. Our salesman has lost his time and we have lost ours and we have talked up a deal for the benefit of one of our competitors, as we have to notify our customer that we can't fill the order. There are not so many machine tool dealers in the country but what manufacturers could, without overexertion on their part, keep them posted as to their sales arrangements, and also on their new designs by sending out up-to-date printed matter. The majority of the new catalogues that we receive we have to ask for, although when a manufacturer gets out anything new one day's work in his office would suffice to supply all the machine tool dealers in the country with this information. The greatest assistance we get is through the medium of the trade journals, and this gives us the opportunity of thanking you very much for keeping us posted in the manner you do.

* * *

TECHNICAL LITERATURE

It does not seem to be an exaggerated statement that at least fifty per cent of the technical books brought out to-day in America have been written merely to satisfy the ambition of an author who wants to see his name on the title page of a book, and published simply because the publisher expects to make a profit on the book, and for no other reason. A great many technical books are practically nothing but abstracts and compilations of other books previously published, containing hardly anything that is new and original, not even in the treatment or arrangement of the matter; and in some cases these new books are even inferior to works that have been previously published. Such books have, therefore, no excuse for their existence except the ambition of the author and their money-making possibilities.

Technical books of real merit are few and far between. In this respect a decided difference has been noted by many book reviewers between German and American books. German technical books and English as well, are noted for their thoroughness, logic and originality. The "padding" so common in many American works, is almost always absent from German technical publications. The German mind especially appears to be particularly adapted for arranging the material properly, systematizing it in such a way as to lead the reader or student from subject to subject by easy stages, and provide him, at the end of the journey through the book, with a clear, comprehensive conception of the subject treated.

There have been many reasons advanced for this difference between German and American books. The most plausible is that the "hustling" of American life shows itself in its technical literature. It is produced in haste, and too little attention is given to detail. Perhaps this is because many of our books are not the works of authors with ample time for investigation and study, but of actual workers in the industries who cannot give a large portion of their time to book writing. This last feature is one of the redeeming characteristics of some American technical books. Written by men actually engaged in practical work, with all their faults of illogical arrangement, unbalanced contents and lack of comprehensiveness, they are more practical, more thoroughly in touch with the industrial conditions, and better adapted to the use of the every-day man, than the more thorough-going and comprehensive German works.

The demand for books written in the popular style is perhaps accounted for by the limited educational advantages of a large number of technical book buyers, represented by the workers in every trade; but even this feature presents no excuse for the production of books which are simply "hashed over" from the writings of other authors, because a popularly written book is capable of just as logical arrangement and even more original treatment of the subject than a more scientific treatise.

WHEN TO SAFEGUARD MACHINERY

Machine designers, manufacturers, and others concerned with the production of machinery are slowly awaking to the fact that it is not good design or business policy to put machines on the market having unprotected gears and other danger points. The movement for greater safety in industrial pursuits has already had a marked effect on machine design, but there is still great need of improvement in this respect, in the construction of many classes of machinery. In an editorial in May, 1907, we made a point of the fact that the time to safeguard danger points in machinery is when the design is on the drawing-board. The designer can cheaply and effectively provide guards in the original design of the machine, whereas they might be cumbersome or entirely out of the question after the machine had been built in the ordinary way. We suggested that "safety of operation should be placed on a par with mechanical efficiency, and that our schools of mechanical engineering could do no greater service for the manufacturing interests of the country than to instil this principle in the minds of their students."

Mr. R. C. Bolling, of the United States Steel Corporation, at the recent annual meeting of the Museum of Safety and Sanitation, New York, spoke of the difficulty of providing effective safety devices on machinery that had not been designed for them. He said that the United States Steel Corporation, which is spending about $1,000,000 annually for accident prevention and compensation to injured workmen, has experienced great difficulty in protecting danger points on machines, cranes and other appliances that had been unprovided with these desirable accessories when built. In fact, it was practically impossible in some places to provide railings for runways and protection for gears, because of lack of clearance, etc. Such provision would have made necessary the re-construction of roofs, changes in foundations and in the whole lay-out of the mill, amounting practically to a reconstruction of the plant. Mr. Bolling said that almost all the machines, cranes and other apparatus could have been adequately protected in the original construction with little or no additional cost; but when provided afterward the expense was very heavy.

We reiterate that the time to safeguard machinery is when it is on the drawing-board; and designers should awaken fully to a sense of their responsibility in this respect. They should consider safety as of equal importance with operating efficiency, for if the machines, unprotected, are not safe to work, they are failures, no matter how efficient they may be as producers. Finally, manufacturers and all users of machinery should fully comprehend the significance of the Museum's motto: "Prevention is a benefaction—compensation an apology."

* * *

THE AUTOMATIC MACHINE AS A CIVILIZING AGENT

It is the fashion among certain critics of the present social order to cast aspersions on the automatic machine as compared with the hand processes which it has displaced. The old idea that it throws workmen permanently out of employment has been pretty thoroughly exploded; but there still remains a vestige of the ancient superstition that ingenious inventions tend to degrade labor. It is claimed that the workman becomes a part of the machine, performing in unison with it the few movements of feeding or adjustment which it is impracticable for the machine to perform by itself.

With this unfriendly view of the automatic machine we boldly take issue. There are without doubt many instances in which the criticism holds good, but this condition is only a passing phase of development. The application of automatic feeds, for instance, has relieved and will continue to relieve the operator of tiresome routine work. We shall eventually change our belief that the only mechanisms which can successfully be made self-acting are those which may be operated by unskilled labor. The time is approaching when mechanisms will be found profitable which require the attention of mechanics of the very greatest skill and experience. As the field thus broadens, mechanics of all grades of ability will become more and more engaged in the work of supervision, instead of being bound to the monotonous repetition of manual movements required for hand work or machine feeding.

The continued development of the automatic machine holds out hope to the workman for relief from much that constitutes the drudgery of labor.

* * *

SALARIES VS. PROFITS

A STUDY IN SHOP AND OFFICE MANAGEMENT

POLYCON

The draftsman, usually, has an excellent opportunity to study methods of shop management and general business systems. Except in some of the largest establishments, he has free access to the shop, and usually avails himself with more or less freedom of the opportunity to study shop methods and, incidentally, to break up the monotony of close confinement to the drawing-board. His work, too, brings him more or less into contact with foremen and workmen, and he is thus in a position to learn the shop view of matters with some degree of accuracy. In addition to this, the drafting-room being a sort of neutral ground between shop and office, he is often able to get something of an insight into office methods, more particularly as regards the ordering and cost-keeping departments. It has been the writer's fortune, good or bad, to have wandered considerably, and to have been employed in establishments doing a wide variety of business, from pure manufacturing to pure engineering, including various admixtures of these two extremes. Although making no pretensions to speak authoritatively on the subject, I have always been rather a close observer of shop management, and a comparative description of some of the systems I have seen might be of interest.

Cost Systems

Shop *A* was engaged in the manufacture of gas and steam engines and boilers for use in the oil fields, besides making general oil-well supplies and attending to repair work. The shops were modern and employed about four hundred men, and the output was limited to a few standard sizes. The cost system was handled by one clerk, and there was one foreman to each of the usual departments, machine, forge, foundry, pattern, and boiler shops. The stock was kept by a young man, and was delivered to the workmen as required, on an order from the foreman.

Shop *B*, where I was employed immediately after leaving *A*, was engaged in exactly the same line of work, with the addition of a general line of plate work, such as tanks and pen-stocks, and the development of a line of larger sizes of gas engines. On account of these latter branches a large force of draftsmen was maintained, while in the previous position I was alone in my glory. The number of men employed was but inconsiderably greater than in the case of *A*, but the cost department included three or four clerks, all of whom appeared to have enough to do, and each foreman had a clerk. In order to get a piece of drill steel or a machine screw from the stock-room, it was necessary for the workman to get an order from the foreman, take it upstairs to the cost department to have it signed, and then get the material from the stock-keeper, who, by the way, also had an assistant.

Now it is significant that while the *A* company was paying a good dividend to the stockholders and was also able to give its employes, as a Christmas present, a substantial bonus based on their wages, the *B* company not only was not paying dividends on the stock, but was in actual financial difficulties. I do not say that the elaborate cost system was the sole cause of the trouble with *B*, but I do believe that a simpler system would have been sufficiently accurate for the purpose, and would have saved thousands of dollars yearly.

Office Systems

The first establishment under this heading, *C*, was engaged principally in the manufacture of mining and ore-handling machinery, and had modern and well equipped shops employing five or six hundred men. Having a well-established business, the selling was done chiefly by correspondence and by one or two supply houses in the mining districts, beside which the general manager and engineers

took occasional trips when something "big" was in the air. The business of this company was handled by the president, general manager, treasurer, and purchasing agent, with a staff of clerks and stenographers not exceeding five. All of the above officials, as well as the superintendent and some of the engineers, were stockholders in the company, were receiving satisfactory salaries, and there was a spirit of hearty cooperation evident among them.

Company *D* was also engaged in manufacturing, mining and ore-handling machinery. The office building was a handsome four-story structure, and the shops, employing about the same number of men as *C*, were well built and equipped with the most modern tools and appliances. This company had a president, general manager, works manager, secretary, treasurer, purchasing agent, auditor, sales manager, two vice-presidents and a chairman of the board of directors, most of whom were relatives of the original members of the firm and drew large salaries, their assistants, in some cases, doing the work.

It is not difficult to understand that while *C* was paying dividends, *D* was not, and further, was in serious financial difficulties. Both companies maintained large and efficient engineering staffs, had well-equipped shops and an established reputation in their lines of business, and it could not but be patent to the most casual observer that the profits in the case of *D* went to pay large salaries to supernumeraries.

Shop Systems

The next shop to be considered, designated as *E*, was one which had grown from a jobbing shop and, at the time that I worked there, employed about four hundred men, building steam engines, boilers, mining machinery, saw-mill and pulp-mill machinery, and general plate work. The buildings were frame structures, inadequate for the work, and the tools were—some of them—fit only for the scrap heap. However, there were some good, heavy machines, and, with good management, the plant should have been capable of producing a fair output. As stated, the shops had grown from small beginnings at a time when business was plentiful and prices good, and the company had always been able to pay good dividends. Being a close corporation, practically owned by three men actively engaged in the management, one of whom was the general manager, a sharp eye was kept on the balance sheet. This being so, it seems strange that the shops were not maintained in a more efficient state, but, on the contrary, the manager's sole idea of economy seemed to lie in the reduction of expenditures. In order to get the work out cheaply, all sorts of patchwork was done on the patterns, metal was skimped to the limit, an excess of scrap and a low grade of pig was used, and the machinery was often shipped out only half finished. All through the shops an excessive number of apprentices was employed, and laborers were doing work which should have been done by skilled mechanics; in the office, the highest salaried man outside of the general manager and the treasurer received $150 a month. At the same time, the cost system was only used to obtain the total cost of a new size or design of machine; it gave no idea of where the loss or profit occurred, and was not followed up for duplicate machines. The natural result of these methods was that this concern was losing more in bad castings and mistakes than was saved by the false economies, and continually the few good workmen employed would leave because the firm was not willing to pay them as much as someone else would pay.

In sharp contrast to this was plant *F*. Here the spirit was to do the kind of work best suited to the requirements, to improve the equipment as fast as financial conditions would warrant, to pay such wages as would attract and keep the best men, and to keep down costs by finding out exactly where losses occurred and then rectifying the conditions causing the loss. Each month an accurate and complete statement was made up, showing the number of men employed and their wages, the cost of material consumed and the output, with a comparison with previous months. The foundry had to make a daily report of all castings, giving the names of the molders whose castings were spoiled and the cause thereof, and every foreman was made to feel that he was there to improve the output in quality and reduce the cost.

Conclusions

And now to point the moral! Not that it is necessary to do so, for it seems as if the conclusions were self-evident. However, the officers of any corporation owe it to the stockholders to so conduct the business as to pay a reasonable profit in the form of dividends. Too many corporations are like *D*: they pay large salaries to the officers and provide remunerative and not-too-laborious employment for sons and sons-in-law. Others, with perfectly honest intentions, are overburdened with systems or are swamped by an overweening vanity on the part of the officers, manifesting itself in elaborately-fitted offices and lavish but ineffective advertising. Still others are being wrecked by incompetent or too daring engineers, who undertake unusual contracts without sufficient investigation of the conditions and requirements, with the result that the work as finally designed over-runs the estimate excessively.

The best results, however, would be obtained if the order and cost systems were kept in the simplest possible form consistent with obtaining accurate and reliable results; the same rule should apply to the business management. In the shop it is good economy to pay fair wages and to insist on a fair return of work therefor. System is a good thing, but, like most good things, it is possible to have too much of it and, therefore, "be temperate in all things" is good advice in the business world, as elsewhere.

* * *

THE POWER OF LARGE GUNS

A gun may properly be considered as a prime mover, and its output may be expressed in terms of horsepower. As, however, the period of time during which energy is exerted is very short, the horsepower expressed in figures becomes rather startling. A calculation involving the horsepower of the large 16-inch gun mounted at Sandy Hook, for instance, will reveal more than anything else the enormous size and power of this gun. The projectile weighs 2,370 pounds and has a muzzle velocity of 2,300 feet per second. The energy developed at the muzzle is about 88,000 foot-tons. If we assume that the projectile moves through a distance of 33 feet within the gun while acquiring the given velocity, and that the acceleration of the projectile is uniform until the muzzle is reached, the mean velocity of the projectile while within the bore would be $\frac{2,300}{2} = 1,150$ feet per second, and the period of time during which the energy of 88,000 foot-tons is developed would be $\frac{33}{1,150} = \frac{1}{35}$ of a second. This corresponds to a total of $88,000 \times 35 \times 60 = 184,800,000$ foot-tons per minute. Since the horsepower = 33,000 foot-pounds, or 14.7 foot-tons per minute, we have $\frac{184,800,000}{14.7} = 12,600,000$ horsepower, as the power developed by the gun during the period and conditions mentioned.

* * *

In accordance with the factory and work-shop act of Great Britain, the British Government has issued regulations relating to safety arrangements to be used in dry grinding and finishing processes. According to these rules all grinding wheels must be provided with a hood or other appliance so constructed and arranged as to take care of practically all dust created. A duct of adequate size arranged to carry away the dust must be provided, and a fan or other effective means for extracting the dust must be installed. Suitable respirators must also be provided for all persons employed in grinding, whether working in a room or in the open air. No person is permitted to do any work other than grinding in a room where grinding is carried on, except work required for cleaning purposes. Provisions are also made for effective cleaning of rooms in which grinding is carried on, at least once a week. The employer is required to furnish all safety apparatus, respirators, etc., and every person employed is required to make full and proper use of the appliances provided.

LAYING-OUT AND ALIGNING OPERATIONS ON MACHINE TOOLS—1*

ALFRED SPANGENBERG†

In general, laying out is the process of placing such lines on castings, forgings, or partially finished surfaces, as will designate the exact location and nature of the operations specified on the drawing; an aligning operation, as its name implies, consists in lining-up a shaft bearing, bracket, or other similar machine element, in its proper place relative to other members. The first-named operation usually is associated with the process of machining, while the last-mentioned is generally included in the work of assembling. Laying-out and aligning operations may be divided into two parts: the preliminary and the final. The preliminary operation consists in approximately locating a machine element in place for the purpose of marking the clamping bolt holes on its supporting member; in the final alignment, the exact location is ascertained for the purpose of drilling the dowel pin holes, the work being held by its clamping bolts. Clearance in the bolt holes permits of this adjustment.

As the ultimate results obtained in assembling are controlled to a large extent by the accuracy of these operations, it is of the utmost importance that means be provided for insuring the refinement that the nature of the case demands. Jigs and fixtures have, of course, been a dominant factor in dispensing with much of the ingenuity and skill required in this work, but owing to special considerations a preclusion of these valuable adjuncts to manufacturing work may be advisable. In this case a simple gage or templet, or even a wooden jig provided with steel bushings, will greatly facilitate the operation of laying out or aligning, and, in fact, when proper care is exercised in using these comparatively crude devices, work may be produced on an interchangeable basis as good as with more expensive tools; although it is to be expected that more skilled labor will be required.

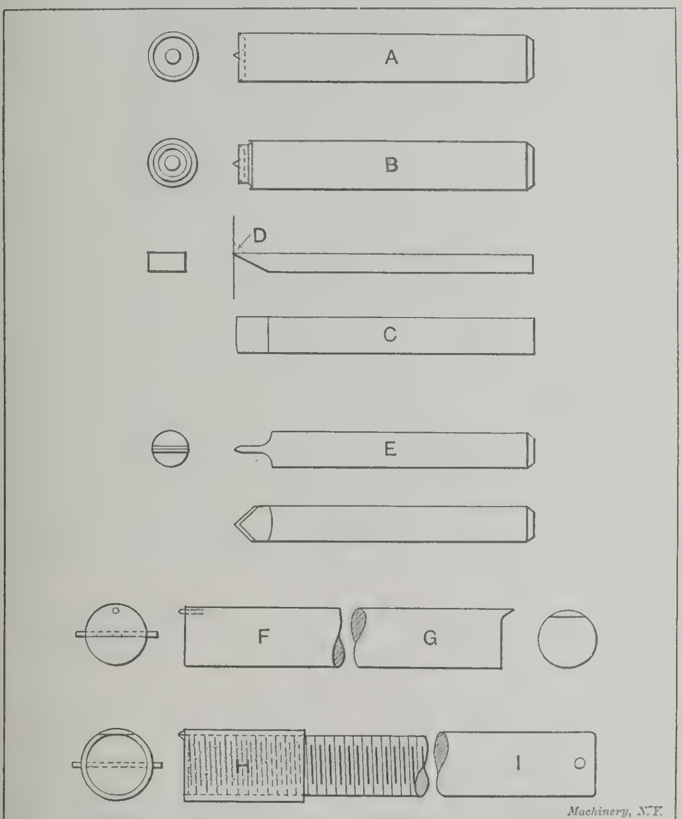

Fig. 1. Special Tools used in Laying-out Operations

As regards the different methods of laying out and aligning, no definite rules can be given. The machinist must consider the means at hand and the nature of the job; he must then use his ingenuity and be guided by his practical experience. A few special cases are illustrated in the accompanying line-engravings; the methods and processes shown and the remarks made in regard to them are intended only as suggestions of how the work may be accomplished without the employment of drill jigs. It is not to be inferred that the way shown is, in each instance, the best method possible and the only one applicable. Circumstances alter cases; while the methods shown may be eminently suitable for one set of conditions, they may either be too refined or not refined enough for other conditions and requirements.

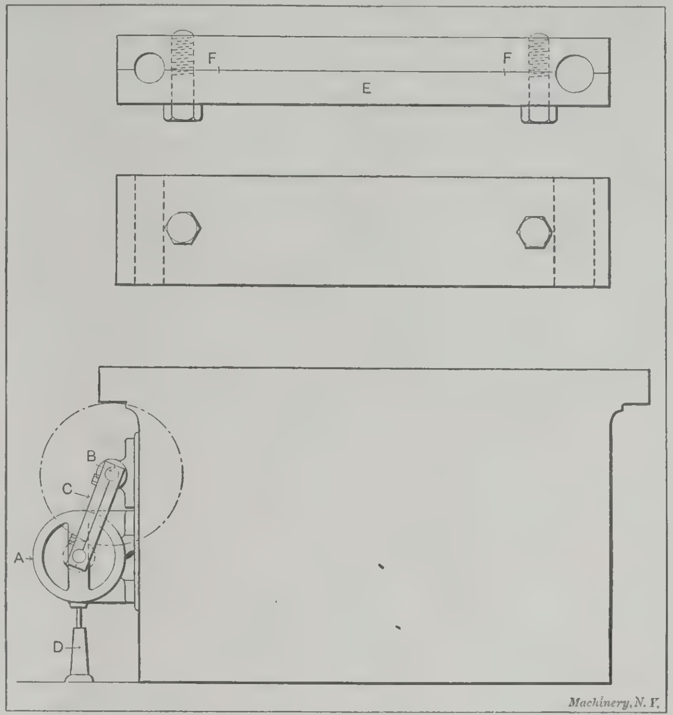

Fig. 2. Locating a Small Motor by the Use of a Link

Special Tools and Appliances

Aside from the more common laying-out tools such as the dividers, surface gage, steel scale, etc., there are a number of tools of a special form used for laying-out operations, some of which are shown in Fig. 1. The form of center punch shown at *A* will greatly facilitate marking off holes through brack-

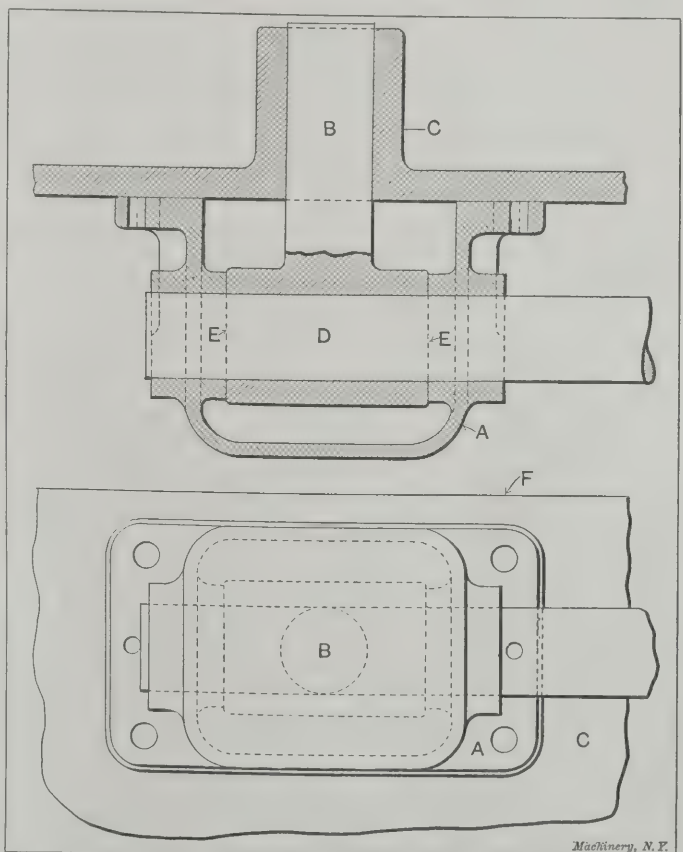

Fig. 3. T-jig for Locating a Bevel Gear Bracket

* For additional information on this and kindred subjects see "Assembling a 48-inch Motor-Driven Planer," in the December, 1909, issue of MACHINERY, and other articles there referred to.

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ets and templets, or in laying off pin holes for cams. It is necessary to provide a number of different sized center punches of this type, as the body of the punch must fit the clearance hole in the work. For obtaining a circle, the diameter of the tap drill, the punch or marker may take the form shown at *B*, while a combination of the two will provide a guard circle.

A flat scriber *C* is very useful for marking a line on a plane surface at right angles to another plane surface when the corner is rounded as shown at *D*. The form of marker illustrated at *E* is for giving permanence to lines intersecting on surfaces at right angles, as for instance, in marking the relative position of a gear on a shaft. At *F* is shown a special marker for laying out a circle, the center of which must coincide with a hole already bored. The body of the marker fits the bored hole and a circle is scribed in the piece to be marked off by rotating the marker when the point is in contact with the work. Two methods of making the scribing point are clearly indicated in the engraving, the one shown at end *G* producing a circle the diameter of the body. In marking off a hole in alignment with a threaded hole, a bushing *H* having a scribing point is made to fit the threaded arbor *I*. This arbor fits the threaded hole, and the bushing is rotated to mark the circle.

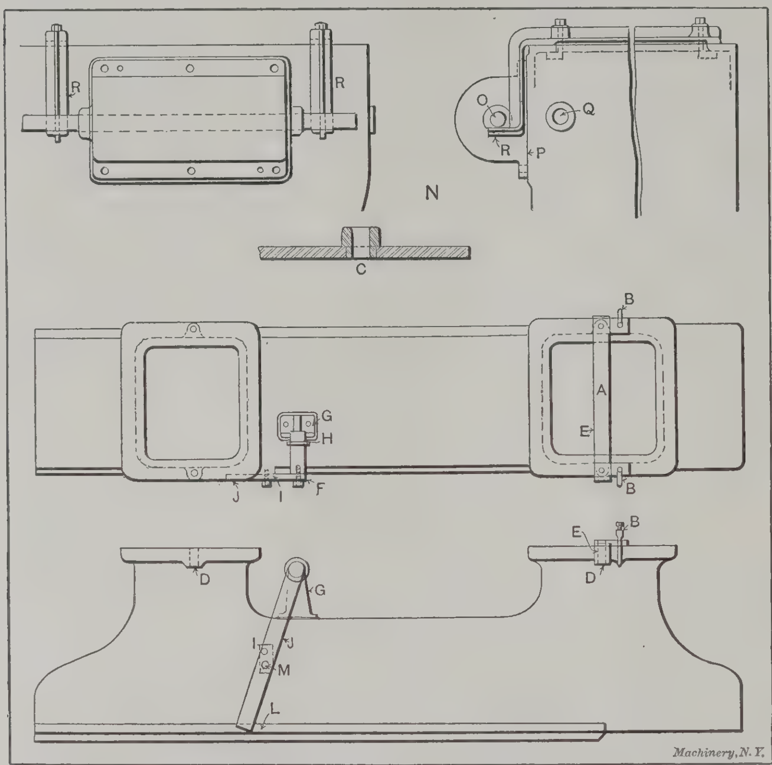


Fig. 4. Special Gages and Templets for Laying-out and Aligning Operations on a Turret Lathe Bed

One of the most convenient and accurate methods of locating gear centers is by the use of links. For drilling or boring operations the link may take the form of a casting provided with hardened steel bushings to guide the cutting tools. Again, a link may be used for cases similar to the one shown in Fig. 2, which illustrates the method of accurately setting a small motor *A* so that its pinion will mesh properly with a gear on shaft *B*. The work is accomplished as follows: With the link *C* and the motor in position as shown, the jack-screw *D* is adjusted until the motor frame just touches the finished seat on the bed. This adjustment is determined by means of tissue paper placed between the motor and bed, after which the bolt holes are marked off on the bed; the special marker *B*, Fig. 1, is used for the purpose. The construction of the link is clearly shown at *E*, Fig. 2; this form, being made of two pieces bolted together, permits of ready application to a shaft supported between bearings, without removing the shaft. Such a case is frequently met with in applying a geared pump to a machine already built. For ordinary cases, however, the link may be made in one casting or forging, as the circumstances require, and provision for clamping may be made by sawing through the ends as far as indicated at *F*.

In Fig. 3 is shown a T-jig for locating a bearing bracket *A* relative to the hole *B* in the main casting *C*. The requirements are that the axes of hole *B* and shaft *D* must intersect, and the faces of hubs *E* must be equidistant from the axis of *B*. It is evident, however, that the T-jig will not take care of the alignment of the shaft *D* with reference to its being parallel with the surface *F*. This may be accomplished by measuring down from surface *F* with either a combination square or surface gage or, in case the adjacent bearing for shaft *D* is already located, bracket *A* will find its own alignment by using this bearing to support the shaft.

The Use of Templets

When a number of pieces are to be made interchangeable without the use of jigs or fixtures, this can be accomplished by the employment of templets for laying out the work. While these devices greatly simplify laying-out and aligning operations, they are not intended for guiding the cutting tools. Templets are particularly well adapted for work where the holes to be laid out lie in the same horizontal plane, and, owing to this condition, the templet usually takes the form of a flat plate of sheet iron, or a wooden piece, having the same general outline as the work to be laid out. Again, many irregular forms are drawn on work from accurately filed templets, after which permanence is given the lines by dotting them with prick-punch marks placed directly on the line.

In making a templet for the first-mentioned class of work, holes are drilled in the templet to conform to the drawing of the piece to be laid out. In use, the templet is laid on the work and is then clamped to it by suitable and convenient means, so that its outline coincides with that of the work. The layout may be transferred to the work by means of a marker as already explained, or, in the case of comparatively large holes, an ordinary scriber is used to mark the circles, and after the templet is removed from the work, the center of each circle is laid out with dividers, permanence being given the lines by a prick punch. Witness circles are often placed on the work to make sure that the original lines were closely followed in drilling, *i. e.*, a circle is drawn in each case 1/32 inch larger in diameter than the one worked to; then, if the hole is correctly drilled, it will be concentric with this circle.

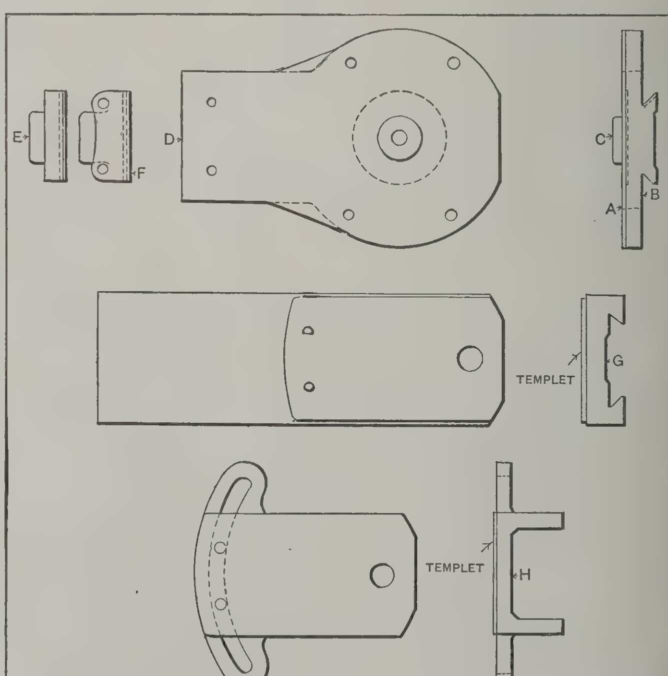


Fig. 5. Sheet Iron Templets for Laying out Planer Crossrail Members

For a certain class of work where great accuracy is not required, templets may be made provided with hardened steel

bushings for guiding the cutting tools independently of the skill of the operator, in which case, however, the templet takes the form of a jig. Owing to the lack of rigidity due to the thin material of which such jigs or templets are constructed, no attempt is made to provide clamping arrangements. The templet may be clamped to the work by means of ordinary C-clamps, or with machinists' clamps. Very frequently, however, it is desirable to provide locating points which may consist of pins extending from one or both sides of the templet, as the case may require, or the locating points may be formed by bending the edges of the metal to a right angle.

The application of a jig such as just described is illustrated in Fig. 4, which shows the method of drilling foundation bolt holes in a turret lathe bed, the holes being drilled from the bottom. As will be seen, the jig or templet *A* consists of three pieces of flat iron riveted together and clamped to the bed by means of clamps *B*. The method of inserting the drill bushings is shown in detail at *C*. To facilitate setting the jig with reference to the bosses *D* on the under side of the bed casting drilling the tap holes in the lathe bed, not shown. Steel lining bushings *E* are provided for the drill bushings. The jig and work are clamped to the drill press table by straps and bolts. The frame consists of four pieces of ash fastened at the corners with blue and wood-screws, the joints being made as shown. Ash is the best wood for the purpose, since, if well seasoned, it is less likely to warp than any other, but where this wood is not available, maple is a good substitute.

A slightly more expensive, but more durable jig, for the same purpose is shown at *F* in the same engraving. This jig is made of flat bar steel riveted together, and is of the same general construction as the wooden one.

Gages for Aligning Operations

A gage may briefly be defined as any standard of comparison; as here used, the term gage will have reference to special devices for aligning work without the employment of ordinary tools such as a combination square, surface gage, etc. Besides greatly facilitating aligning operations, the particular

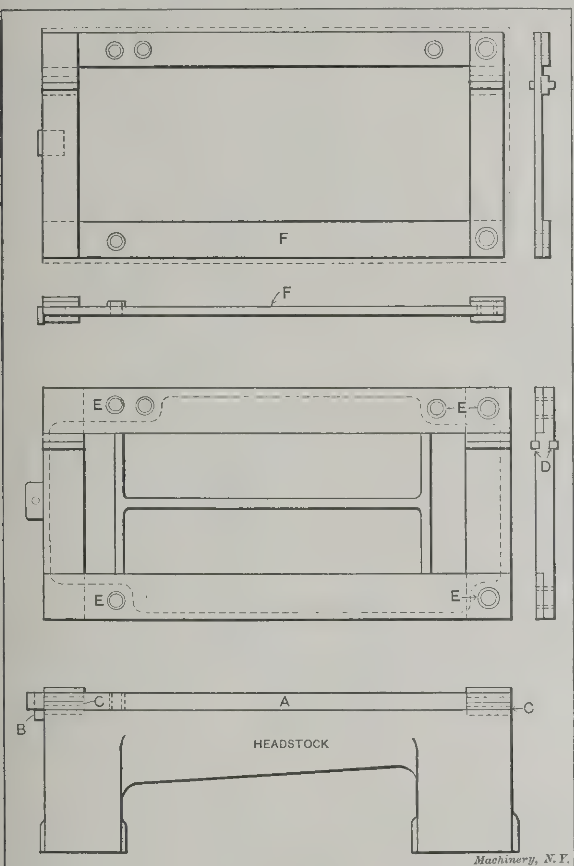


Fig. 6. Application of a Wooden Jig for Drilling a Lathe Headstock. At F is shown a Similar Jig constructed of Flat Bar Steel

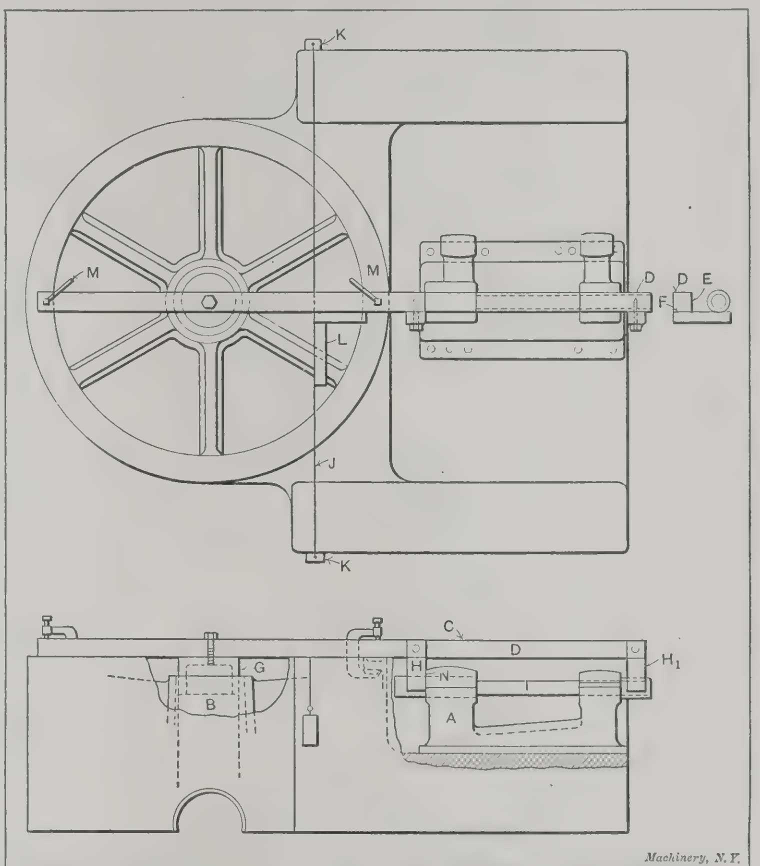


Fig. 7. Gage for Aligning the Driving Shaft Bracket on a Vertical Boring Mill of the Bevel Gear Driven Type

so that the holes when drilled will be concentric with these bosses, jig member *E* is bent to a right angle at each end so as to extend down the casting; the location is determined by matching these ears with the bosses on the bed.

In Fig. 5 is shown the application of sheet iron templets for laying out cross-rail members for large planers. Templet *A* for swivel member *B* is located by the hub *C*, and is lined up to match the end *D*. A separate templet is provided for laying out the swivel clamp *E*; edge *F* of the templet is bent over to form a locating point. But one templet is required for laying out slide *G* and its clapper-box *H*. This is lined up on each member as shown. It is obvious that these templets are more advantageous than cast iron jigs for this class of work, since very large and heavy jigs would be required, and furthermore, no great accuracy is necessary, as the bolt holes have 1/16 inch clearance.

As already stated, a very cheap and serviceable jig for certain classes of work can be constructed of wood. At *A*, Fig. 6, is shown a jig of this character for drilling the clamping bolt holes in an engine lathe headstock—in this case for a 30-inch lathe. The jig is located by pin *B* and keys *C*, the latter fitting a keyway in the headstock; having these keys on both sides of the jig as shown at *D*, it is also used for

advantage of using gages is that the possibility of error due to carelessness in transferring scale measurements is avoided. It is assumed, however, that the gages here shown are intended only for duplicate work; it would not be economy to make gages for aligning only a few pieces.

Turning back to Fig. 4, *F* represents a simple gage for aligning bracket *G* on the bottom of a turret lathe bed. The requirements are that face *H* of the bracket must be a certain definite distance from seat *I* on the bed, but the alignment in a longitudinal direction is non-essential. The gage merely consists of two pieces: a straightedge *J*, planed only on one side and one end, and a gage which is fastened to the end of the straightedge as shown. As surface *L* on the bed lies in the same plane with seat *I*, the straightedge is made long enough to reach this surface, thereby obtaining greater accuracy in the alignment. Bolt hole *M*, already tapped, is utilized for clamping the gage. In aligning the bracket, its face is brought into contact with the gage, and the bracket is then set longitudinally to match its seat on the bed.

Another gage, or more properly speaking, a pair of gages, for aligning a feed-box on the turret lathe bed shown in the lower part of the same engraving, is shown at *N*. The requirement of the present case is simply that the feed-box shaft

hole O be located a certain definite distance from the top of the bed; seat P on the bed takes care of the center distance from hole Q. It is obvious then, that the gage castings R should only provide a positive locating surface with reference to the top of the bed; this is accomplished in the manner shown. The location endwise is determined by scale measurement from the end of the bed.

An aligning operation on a vertical boring mill bed, and the gage used, is illustrated in Fig. 7. This boring mill is of the bevel gear driven type, in which the pinion meshing into the table bevel gear is carried on the driving shaft in bracket A. The problem of aligning this driving shaft bracket with reference to the spindle hole B in the bed, is easily solved by using gage C. As will be seen, this gage consists of a bar D planed on two sides, E and F; a bushing G fitting the spindle hole; and two gage pieces H and H_1. A special arbor I, having both its ends ground to the same diameter, fits bracket A.

When in use, a line wire J is stretched across the bed by means of weights K. This wire lies in a small groove or mark planed in the bed for the double purpose of squaring the gage and setting the housings. Square L is used in setting the gage before it is clamped by means of clamps M, so that when the bed members are assembled, the driving shaft will be approximately square with the housing faces. With the gage in this position, bracket A is set so that its arbor just touches the gage blocks H and H_1. The location with reference to the distance from spindle hole B in the bed is determined by simply bringing the hub face N on bracket A into contact with the side of gage block H. After the operation of marking off the tap holes in the bed is accomplished, and the holes are drilled and tapped, bracket A is reset in the same manner and clamped by its bolts, for drilling and reaming the dowel pin holes.

* * *

A few years ago mahogany was regarded as a very precious wood and was employed only for the interior finish of the finest houses and in the manufacture of high-priced furniture. During the past few years, however, there has been a wonderful development in mahogany importation and use. The total quantity of mahogany imported in 1908 was nearly forty-two million board feet. It is one of the most valuable woods known for other than decorative purposes. As a pattern material it is unsurpassed, being strong, light and not as much affected by rough usage as pine. It takes glue remarkably well and is also superior to pine in that it is not affected as much by dampness.

DERIVATION OF BEVEL GEAR FORMULAS*†

RALPH E. FLANDERS‡

In the present article are given the derivations of the formulas used for calculating the dimensions of bevel gearing for all conditions of shaft angles and types of gears, including bevel gears with shafts at right angles, miter gearing, bevel gears with shafts at acute or obtuse angles, crown gears, and internal bevel gears.

In Fig. 1 is shown an axial section of a bevel gear, the pitch lines showing the location of the imaginary pitch cone. The pitch cone angle is the angle which the pitch line makes with the axis of the gear. The pitch diameter is measured across the gear drawing at the point where the pitch lines intersect the outer edge of the teeth. In speaking of the pitch of a bevel gear we always mean the pitch of the larger or outer ends of the teeth. Diametral and circular pitch have the same meaning as in the case of spur gears, the diametral pitch being the number of teeth per inch of the pitch diameter, while the circular pitch is the distance from the center of one tooth to the center of the next, measured along the pitch diameter at the back faces of the teeth. The addendum is the height of the tooth above the pitch line at the large end. The dedendum (the depth of the tooth space below the pitch line), and the whole depth of the tooth are also measured at the large end.

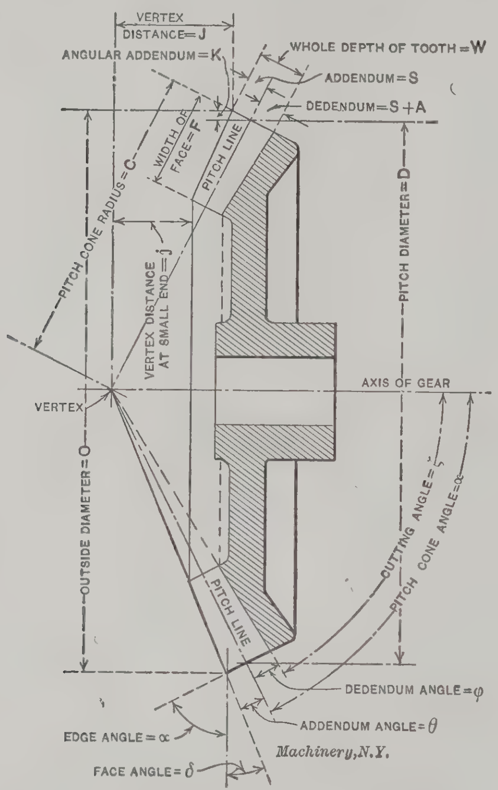


Fig. 1. Dimensions, Definitions and Reference Letters for Ordinary Bevel Gear

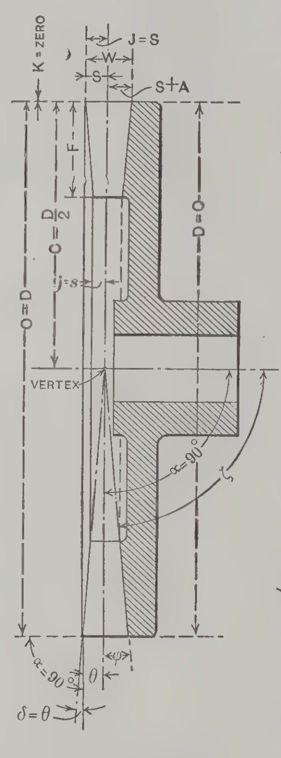


Fig. 2. Dimensions for Crown Gear

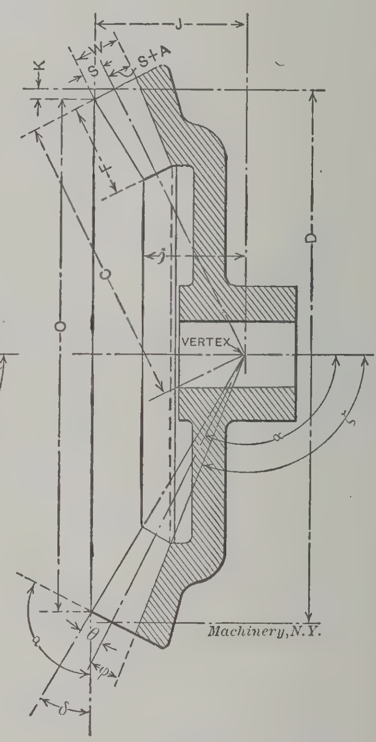


Fig. 3. Dimensions for Internal Bevel Gear

The pitch cone radius is the distance measured on the pitch line from the vertex of the pitch cone to the outer edge of the teeth. The width of the face of the teeth, as shown in Fig. 1, is measured on a line parallel to the pitch line. The addendum, whole depth and thickness of the teeth at the

* With Data Sheet Supplement.

† The following articles dealing with the subject of bevel gearing have previously been published in MACHINERY: Cutting Bevel Gears with Rotary Cutters, January, 1897; Bevel Gear Formula, January, 1898; Cutting Bevel Gears with Correct Teeth, June, 1898; Cutting Bevel Gears, June, 1898; Chamfering Bevel Gears, July, 1902; Bevel Gear Chart, September, 1905; To Calculate the Center Angles of a Pair of Bevel Gears having their Axes at other than Right Angles, June, 1906; Strength of Gears, December, 1906, engineering edition; Bevel Gear Diagrams, May, 1907, engineering edition; Bevel Gear Formulas, May, 1907, engineering edition; Cutting Bevel Gears with a Rotary Cutter, October, 1907; A Bevel Gear Gage, January, 1909; A Bevel Gear Problem, April, 1909. Cutting Bevel Gear Teeth—A New Method of Obtaining the Set-over, December, 1909, engineering edition; Accurate Setting of the Bevel Gear Cutter, December, 1909, engineering edition. See also MACHINERY'S Data Sheet No. 36, September, 1904, Proportions of Bevel Gears; No. 37, October, 1904, Dimensions of Miter Gears; No. 64, December, 1906, Strength of Bevel Gears; No. 69, May, 1907, Bevel Gear Formulas and Diagrams; No. 102, Extra Data Sheet, October, 1908, Table for Determining the Outside Diameter of Bevel Gears; MACHINERY'S Reference Series No. 37, Bevel Gearing.

‡ Associate Editor of MACHINERY.

small or inner end may be derived from the corresponding dimensions at the outer end, by calculations depending on the ratio of width of face to the pitch cone radius. (See s, w and t in Fig. 4.)

The addendum angle is the angle between the top of the tooth and the pitch line. The dedendum angle is the angle between the bottom of the tooth space and the pitch line. The face angle is the angle between the top of the tooth and a perpendicular to the axis of the gear. The edge angle (which equals the pitch cone angle) is the angle between the outer edge and the perpendicular to the axis of the gear. The latter two angles are measured from the perpendicular instead of from the axis for the convenience of the workman in making measurements with the protractor when turning the blanks. The cutting angle is the angle between the bottom of the tooth space and the axis of the gear.

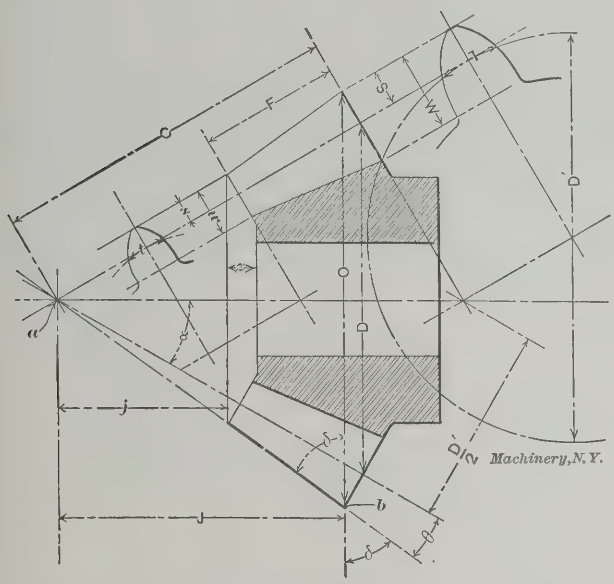


Fig. 4. Diagram Explaining Certain Calculations Relating to Bevel Gears

The angular addendum is the height of tooth at the large end above the pitch diameter, measured in a direction perpendicular to the axis of the gear. The outside diameter is measured over the corners of the teeth at the large end. The vertex distance is the distance measured in the direction of the axis of the gear from the corner of the teeth at the large end to the vertex of the pitch cone. The vertex distance at the small end of the tooth is similarly measured.

The shape of the teeth of a bevel gear may be considered as being the same as for teeth in a spur gear of the same pitch and style of tooth, having a radius equal to the distance from the pitch line at the back edge of the tooth to the axis of the gear, measured in a direction perpendicular to the pitch line. This distance is dimensioned $\frac{D'}{2}$ in Fig. 4. The number of teeth which such a spur gear would have, as determined by diameter D' thus obtained, may be called the "number of teeth in equivalent spur gear," and is used in selecting the cutter for forming the teeth of bevel gears by the formed cutter process.

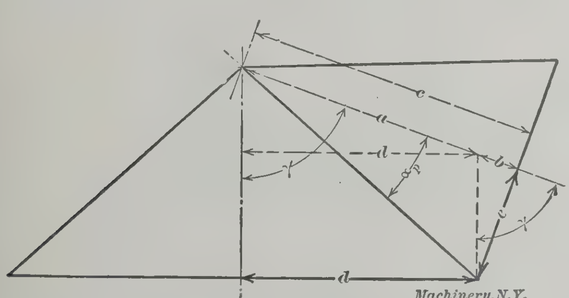


Fig. 5. Diagram for Obtaining Pitch Cone Angle of Acute Angle Gearing

In two special forms of gears, the crown gear, Fig. 2, and the internal bevel gear, Fig. 3, the same dimensions and definitions apply as in regular bevel gears, though in a modified form in some cases. In the crown gear, for instance, the pitch diameter and the outside diameter are the same, and the pitch cone radius is equal to one-half the pitch diameter. The addendum angle and the face angle are also the same. The angular addendum becomes zero, and the vertex distance is equal to the addendum. The number of teeth in the equivalent spur gear becomes infinite, or in other words, the teeth are shaped like those of a rack.

When the pitch cone angle is greater than 90 degrees, so that the gear becomes an internal bevel gear, as in Fig. 3, the outside diameter (or edge diameter as it is better called in the case of internal gears) becomes less than the pitch diameter. Otherwise the conditions are the same, although many of the dimensions are reversed in direction.

Rules and formulas for calculating the dimensions of bevel gears are given in the accompanying Data Sheet Supplement. The following reference letters are used:

N = number of teeth,
P = diametral pitch,
P' = circular pitch,
π = 3.1416,
α = pitch cone angle and edge angle,
γ = center angle (angle between axes of two meshing gears),
D = pitch diameter,
S = addendum,
$S + A$ = dedendum (A = clearance),
W = whole depth of tooth space,
T = thickness of tooth at pitch line,
C = pitch cone radius,
F = width of face,
s = addendum at small end of tooth,
t = thickness of tooth at pitch line at small end,
θ = addendum angle,
ϕ = dedendum angle,
δ = face angle,
ζ = cutting angle,
K = angular addendum,

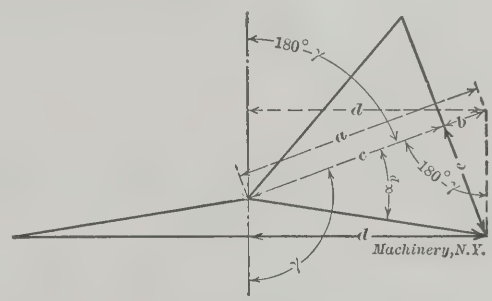


Fig. 6. Diagram for Obtaining Pitch Cone Angle of Obtuse Angle Gearing

O = outside diameter (edge diameter for internal gears),
J = vertex distance,
j = vertex distance at small end,
N' = number of teeth in equivalent spur gear.

Sub $_p$ refers to dimensions applying to pinion (α_p, N_p, etc.).

Sub $_g$ refers to dimensions applying to gear (α_g, N_g, etc.).

It will be noted that directions for the use of these rules are given for each of the six cases of right angle bevel gearing, miter bevel gearing, acute angle and obtuse angle bevel gearing, and crown and internal bevel gears.

Rules and Formulas for Bevel Gear Calculations

The derivation of most of these formulas is evident on inspection of Figs. 1 to 4, inclusive, for anyone who has a knowledge of elementary trigonometry. It is not necessary to know how they were derived to use them, however, as all that is needed is the ability to read a table of sines and tangents.

Formulas 5, 6, 7 and 8 are the same as for Brown & Sharpe standard gears. The dimensions at the small end of the tooth given by Formulas 10, 11 and 19 obviously are to the corresponding dimensions at the large end, as the distance from the small end of the tooth to the vertex of the pitch cone is to the pitch cone radius. This relation is expressed by these formulas. The derivation of Formula 20 may be understood by reference to Fig. 4;

$$D' = \frac{D}{\cos a} = \frac{N}{P \times \cos a}, \text{ also } D' = \frac{N'}{P}$$

$$\text{therefore } \frac{N'}{P} = \frac{N}{P \times \cos a}, \text{ or } N' = \frac{N}{\cos a}$$

Formula 21, for checking the calculations, will also be understood from Fig. 4, where it will be seen that

$$O = 2\,ab \times \cos \delta, \text{ also that } ab = \frac{C}{\cos \theta}$$

$$\text{therefore } O = \frac{2\,C \times \cos \delta}{\cos \theta}$$

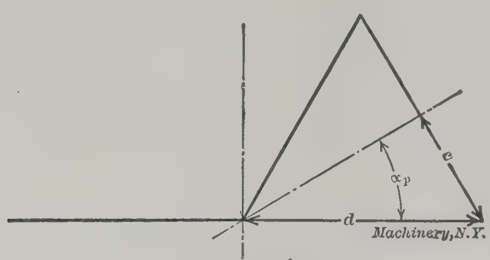


Fig. 7. Diagram for Obtaining Pitch Cone Angle of Pinion to mesh with Crown Gear

Formulas 22 to 27 inclusive are simply the corresponding Formulas 1, 9, 14, 15, 16 and 20 when $a = 45$ degrees.

Formula 28 is derived as shown in Fig. 5.

$$c = \frac{e}{\tan \alpha_p}, \text{ also } c = a + b = \frac{d}{\sin \gamma} + \frac{e}{\tan \gamma}$$

$$\text{therefore, } \frac{e}{\tan \alpha_p} = \frac{d}{\sin \gamma} + \frac{e}{\tan \gamma}$$

Solving for $\tan \alpha_p$, we have: $\tan \alpha_p = \dfrac{e\,(\sin \gamma \times \tan \gamma)}{d \tan \gamma + e \sin \gamma}$

Dividing both numerator and denominator by $e \tan \gamma$, we have:

$$\tan \alpha_p = \frac{\sin \gamma}{\dfrac{d}{e} + \dfrac{\sin \gamma}{\tan \gamma}}$$

Since $d = \dfrac{N_g}{2\,P}$ and $e = \dfrac{N_p}{2\,P}$, and since $\dfrac{\sin}{\tan} = \cos$, we have:

$$\tan \alpha_p = \frac{\sin \gamma}{\dfrac{N_g}{N_p} + \cos \gamma}$$

Formula 29 is derived by the same process for the other gear. Formula 31 (and likewise 33) is derived from Fig. 6, using the following fundamental equation:

$$\frac{e}{\tan \alpha_p} = \frac{d}{\sin (180° - \gamma)} - \frac{e}{\tan (180° - \gamma)}$$

When solved for $\tan \alpha_p$, this gives formula 31.

Rule 32, of course, simply expresses the operation of finding out whether the pitch cone angle of the gear is less, equal to, or greater than 90 degrees. The derivation of Formula 34 is shown in Fig. 7:

$$\sin \alpha_p = \frac{e}{d} = \frac{N_p}{N_g}$$

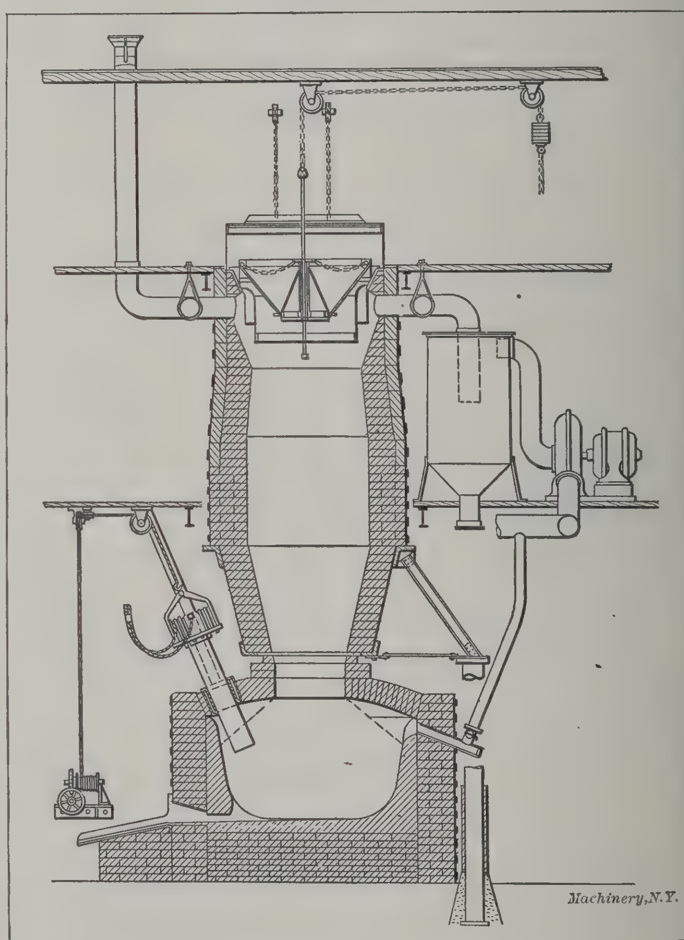
Since in a crown gear the dimension $\dfrac{D'}{2}$ in Fig. 4 is to be measured parallel to the axis, and will therefore be of infinite length, the form of the teeth will correspond to those of a spur gear having a radius of infinite length, that is to say, to a rack. This accounts for Formula 38.

Formulas 39, 40, 42 and 44 are simply the corresponding Formulas 33, 9, 16 and 20 changed to avoid the use of negative cosines, etc., which occur with angles greater than 90 degrees. These negative functions might possibly confuse readers whose knowledge of trigonometry is elementary. The other formulas for internal gears are readily comprehensible from an inspection of Fig. 3.

ELECTRIC SMELTING OF IRON AND STEEL*

At Gysinge, in Sweden, in one of the works belonging to the Stora Kopparbergs Bergslags Aktiebolag, a furnace as shown in the accompanying engraving is installed. This furnace is similar to a common blast furnace, but is provided with three electrodes fed by three-phase alternating current at about 40 volts, 60 cycles and 9,500 amperes, 674 H. P. The electrodes take the place of the tuyeres. This furnace has been running for 1,903 hours and 28 tons of iron, containing from 0.95 to 3.09 per cent of carbon has been produced. The temperature of the escaping gases from the furnaces is generally very low, and they contain on an average about 22 per cent of carbon dioxide. The gases contain practically no nitrogen, but considerable steam from the water in the ore, lime, coke or charcoal is present. No air whatever is used in the process, and the gases are produced from the carbon in the charcoal and coke, and the oxygen in the ores ($FeO + C = Fe + CO$). Either charcoal or coke may be used, but the consumption of fuel will be practically the same in either case.

The line engraving shows a vertical section through the furnace which consists of a lower portion or smelting chamber, corresponding to the hearth of a blast furnace, and a top section or blast. The latter is supported on columns, which prevent any weight from bearing on the arch of the smelting



Electric Blast Furnace built at Gysinge, Sweden

chamber. The latter is so proportioned as to provide a considerable amount of free space between the charge and the arched roof through which the carbon electrodes project into the charge. The brickwork is thus protected against any very high temperature, and remains a non-conductor of electricity. This is an important feature of this furnace, since experiments have shown that if the electrodes enter the chamber at the point where the charge touches the walls, a very high temperature is generated at this point; the brickwork is destroyed and becomes a conductor of electricity, giving rise to a more or less complete short-circuit. The charge is made up of ore, lime, coke and charcoal. The ore and fuel are crushed to a suitable size, and are fed into the top of the furnace through the bell hopper in the usual way.

* Abstract of paper by Mr. E. J. Ljungberg, of Falun, Sweden, read before the Iron and Steel Institute of Great Britain.

THREAD ROLLING*

J. F. SPRINGER†

Of the several methods used for producing threads on screws, the one least understood or known by mechanics in general is the process of thread rolling. When threads are produced by means of this process, the blank, which is held in a machine made for this purpose, is rolled between two dies or blocks, provided on their faces with grooves of the right pitch, form and angle of lead, as shown in Fig. 1. The thread

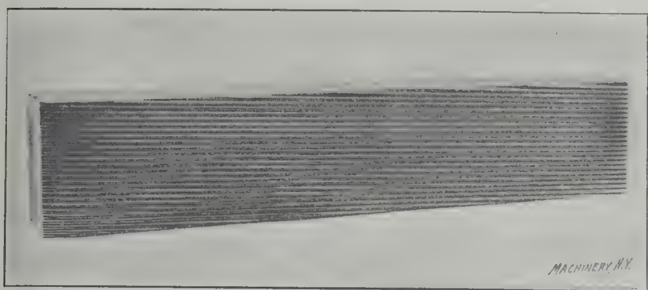


Fig. 1. A Thread Rolling Die for Rolling United States Standard Threads

is formed by the displacement of the metal, some part of which is forced up to form the top of the thread. The finished screw, therefore, is larger in diameter than the blank.

That it is possible to form or roll a perfect thread by means of straight grooves or threads cut into a flat block or die, will be understood by imagining the thread helix as unrolled upon a flat surface. In Fig. 2, for instance, the line AB indicates

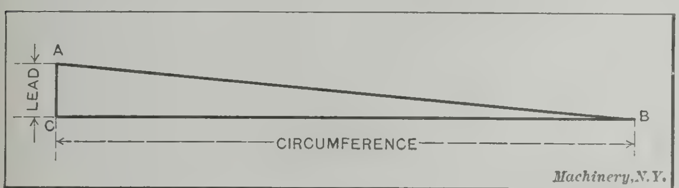


Fig. 2. Diagram for Determining Angle of Threads in Thread Rolling Dies

the helix of a thread thus developed on a flat surface; the line AC is the lead of the thread, and the line BC is the developed circumference of the screw. It is necessary, of course, that the angle of the thread cut on the flat thread rolling die be the same as the helix angle of the thread, which, in turn, is the same as the angle ABC in Fig. 2. The tangent of this angle, of course, equals

$$\frac{AC}{BC} = \frac{\text{Lead}}{\text{Circumference}} = \frac{\text{Lead}}{\text{Diameter} \times 3.1416}$$

These general remarks indicate the main principles involved in the process of thread rolling. In the following some of the elementary matters to be considered in this connection will be treated.

Methods Used for Thread Rolling

There have been a number of methods proposed for carrying out the mechanical operation of rolling threads. As far back as 1851 a machine was built for this purpose. In this machine the blank was rolled between dies or blocks with their faces vertical, one of the dies having a reciprocating motion in a direction at right angles to the axis of the blank. This fundamental idea of construction has been retained in some of the most modern thread rolling machines. Flat dies with their faces placed horizontally have also been used, but there is, as far as the writer knows, no machine of this type now on the market. In another type of thread rolling machine a cylindrical die rotating on its axis and provided with thread grooves on the outside, is set horizontally within a hollow cylindrical die provided with threads on the inside. This thread rolling machine, known as the rotary machine, is at the present time on the market. It has the merit of continuity of production; when one bolt has just been rolled, another is fed in immediately without the necessity of the reversal of the movement which in reciprocating machines causes a period of idleness. The disadvantage of the lost time in reciprocating machines, however, is partially removed by introducing a return movement which is more rapid than the advance; but the continuity of action of the rotary thread roller is, no doubt, an item of importance. A single revolution of the convex die produces, in fact, four bolts.

Automatic Feed for Screw Blanks

There are, however, other things to consider besides continuity of action. An important question is the feeding of the blanks, and the machine having flat dies of the type shown in Fig. 1, set with their faces vertical, lends itself best to automatic methods of supplying the blanks. In such feeding mechanisms the greatest problem probably is that of getting the blanks into the required position for the operation to be performed upon them. A device for this purpose is illustrated in Fig. 3. The blanks for the screws are placed in a hopper A of generous size located at the top of the machine. There is a long slot in the bottom of the hopper through which a flat plate B, called the center-board, is vertically reciprocated. This center-board has a vertical slot whose width is just a trifle in excess of the diameter of the body of the blank. When this slotted center-board rises through the slot in the bottom of the hopper—the motion being actuated by a cam and gearing as shown—one or more blanks are likely to drop, under the influence of their weight, into the slot in the plate. These blanks then hang suspended by their heads as shown. Sometimes, however, the center-board will rise through the mass of blanks in the hopper without any blank being properly located to come into the required position; but the mass of blanks will be disturbed and the next time the board rises some blanks may be caught in the manner necessary for feeding to the machine, and sooner or later one or more bolts will be suspended by their heads. To get a sufficient number to supply the machine, all that is necessary is to proportion the mechanism properly and to operate it at a suitable rate of speed.

Sometimes the blanks will be picked up crosswise or get into other unfavorable positions across the edge of the slotted center-board. An auxiliary device may then be employed to throw off such blanks. In Fig. 3 several blanks are shown

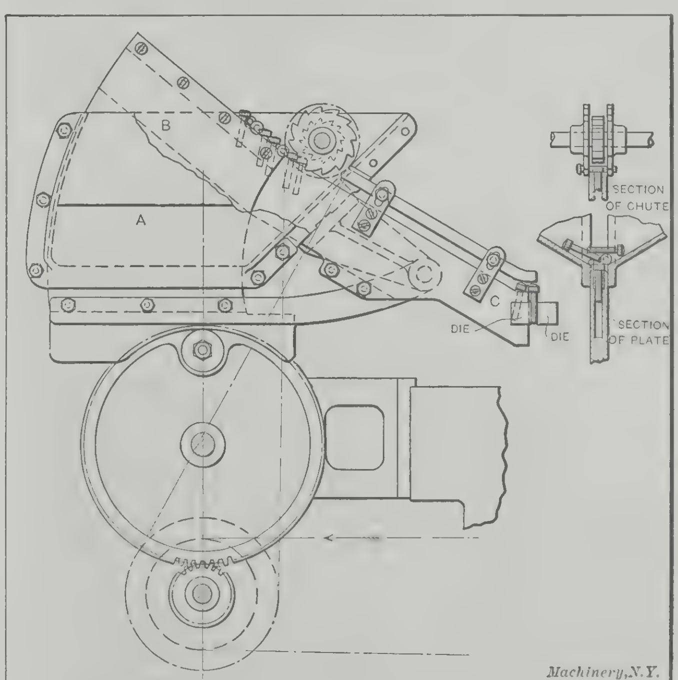


Fig. 3. Automatic Feeding or Hopper Mechanism for Screw Blanks in Thread Rolling Machines

in the proper position in the slot and two others are already delivered to the fixed portion C of the chute, while a number are in unsuitable positions for feeding. As the blanks in or on the center-board move onward to the fixed part of the chute, they pass under and between a rotating system of three toothed wheels of the ratchet-wheel type. The outside wheels pass close to the outer edges of the board, while the inner wheel passes close above the heads of the blanks which are properly caught. This is indicated in the upper sectional

* See MACHINERY, November, 1909, engineering edition: Calculating the Size of Blank for Rolling Screw Threads.

† Address: 625 W. 135th St., New York City.

view to the right in Fig. 3. If a blank is in the correct position in the chute it will not be disturbed by the wheels, but if not, it will be thrown off. The lower sectional view to the right shows a typical situation of the blanks when the center-plate rises through the slot at the bottom of the hopper.

It will be seen in Fig. 3 that as the blanks pass down the inclined chute they are prevented from subsequent displacement by an adjustable guide or keeper passing over their heads. At the end of the chute the direction of the blanks becomes vertical and they are then caught between the dies and the thread rolled. Of course, all thread rolling machines

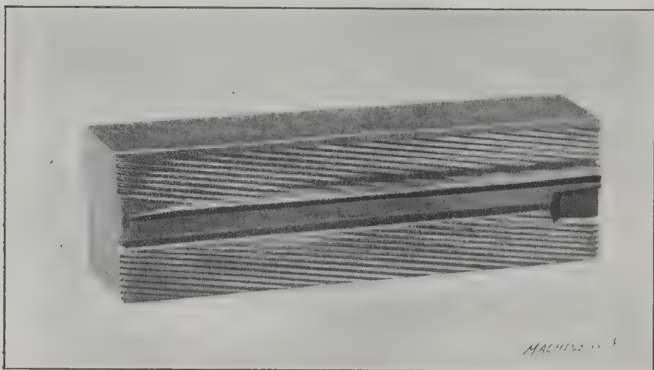


Fig. 4. A Reversible Thread Rolling Die for Wood-screws

are not fed with automatic hoppers of this type. Conditions decide when and when not to employ devices of this kind.

The Thread Rolling Process

One of the thread-rolling dies is stationary while the other has a reciprocating movement. Both dies are exactly the same otherwise except for length. The thread-rolling die shown in Fig. 1 is for a right-hand thread, the grooves inclining downward toward the right. For a left-hand thread, the threads on the dies incline downward toward the left. In Fig. 4 is shown a reversible die. In this die when the upper portion is worn down the lower portion may be brought into service by reversing the die. This die is for rolling wood-screw threads. On account of the gimlet point required, the surface of the die is not flat. In rolling screw threads using one stationary and one reciprocating die, the working face of the moving die must be at least twice the length of the fixed

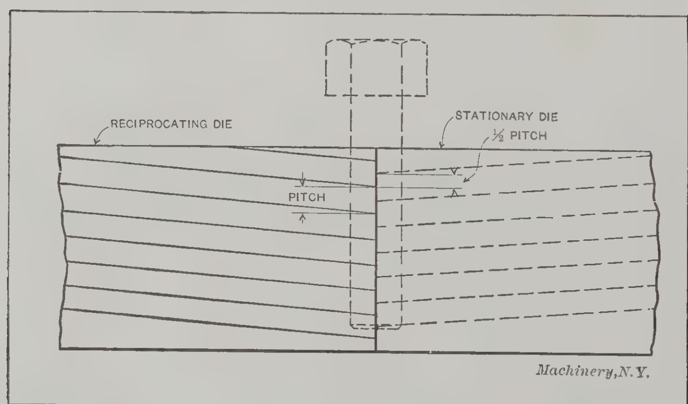


Fig. 5. Diagrammatical View showing the Relative Positions of the Thread Rolling Dies when starting to roll a Thread

die, otherwise the screw blank would not be rolled over the full face of the fixed die, but would be carried back at the return of the movable die. While a good thread might be rolled that way, it would obviously be impracticable to have the screw blank return, if for no other reason than because it would interfere with the blank just fed into the dies.

When calculating the angle of the threads on the die face, the circumference of the die blank should be taken as the length of the side *BC* in Fig. 2. For example, suppose that we wish to roll an ordinary V-thread having a finished diameter of ¾ inch, and 10 threads per inch. The diameter of the blank is found by Formula (11), on page 181 of MACHINERY, engineering edition, November, 1909. This diameter is 0.689 inch, and the circumference of the blank, consequently, 2.165 inches. The screw having 10 threads per inch, the lead is 0.100 inch and hence the tangent of the angle of the thread on the die face $= \dfrac{0.100}{2.165} = 0.046$, giving an angle for the thread of 2 degrees 40 minutes.

A little thought will easily convince one that when starting to roll the thread it is necessary that the grooves in one die be in a given relation to the grooves in the other. The two dies work on the screw on parts separated one-half turn, and as one-half turn of the screw corresponds to one-half of the pitch, the ridges and grooves of points exactly opposite each other must be one-half of the pitch above or below the corresponding ridges and grooves in the other die. (See Fig. 5.) In rolling threads this relative adjustment must be secured, otherwise the thread rolled by one die would not coincide with that formed by the other. It is, therefore, necessary to have vertical adjustment in the slides in which the dies are mounted.

It will be understood from what has been said that not only is it important that the two die faces be adjusted exactly in relation to each other, but also that the blank be started exactly at the time when points on opposite faces of the dies are in the correct relation to each other. It is, therefore,

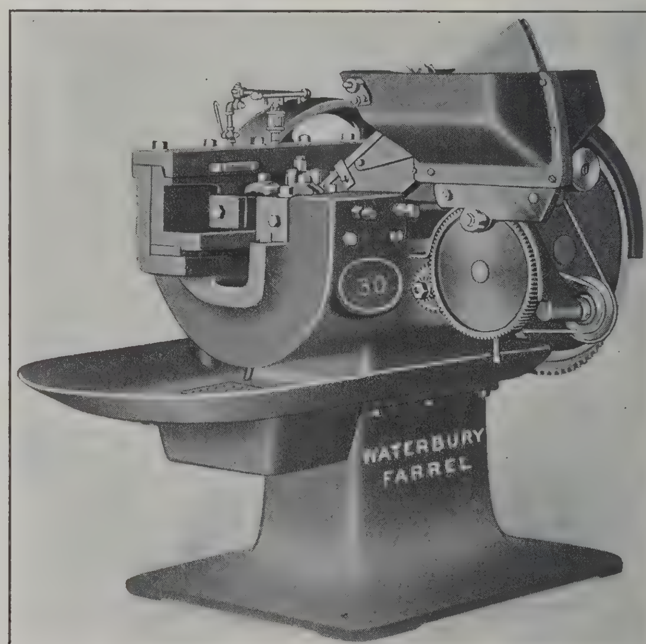


Fig. 6. A Waterbury Farrel Foundry & Machine Co.'s Thread Rolling Machine with Automatic Hopper Mechanism

necessary to have means of adjustment for timing the start of the operation of rolling the blank. For this purpose a starting rod is used. The blank stands with its head pointing upward at the proper level and close to the right-hand edge of the fixed die. The die is cut away at this point so that as long as the blank remains there, no work will be accomplished by the movement of the reciprocating die. The starting rod then forces the blank between the dies at the precise moment when the threads are in the proper relation to each other. The starting rod is usually referred to as the "starter." It is, of course, important that the blank pass through in a perfectly upright position. If it is started vertically there is ordinarily no difficulty in maintaining it so. At the moment of starting, the starter forces it against the vertical edge of the fixed die, which is sufficient for usual requirements. If the blank is very long, it may need support at its upper end; this support in most cases may be given by the hand of the operator.

At the first part of the stroke the bolt is only partially penetrated by the threads in the dies. The dies, therefore, are not mounted exactly parallel, but so that they are further apart from each other at the point where the rolling process commences. When the bolt has rolled all the way through to the left-hand edge of the fixed die the operation is complete and the movable die begins to return. It has been found desirable to provide a means of preventing the bolt from getting

caught and carried back between the dies. Gravity alone cannot be depended upon because of the possibility of the thread on the screw clinging to the moving die. One method for throwing off the work is by the use of a flat spring. One arm of a rather obtuse V protrudes over the upper edge of the movable die. When the bolt comes along its head or upper part strikes this arm of the V, forcing it back; when the work has passed, the arm returns to its normal position, so that it prevents the work from following the die back. The spring

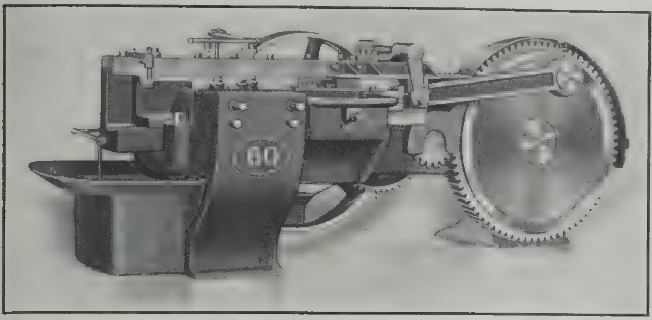


Fig. 7. Large Thread Rolling Machine

will not be pressed back on the return stroke, as the work is not held very firmly to the die.

Advantages of Thread Rolling

As already mentioned, the rolling of threads increases the outside diameter; thus in the example previously given, a blank 0.689 inch in diameter produces a thread of 0.750 inch in diameter, or an increase of 0.061 inch—over 8 per cent. It will be seen, then, that if the diameter of that part of the bolt which is not threaded and the threaded portion are desired to be the same, blanks must be used having a smaller

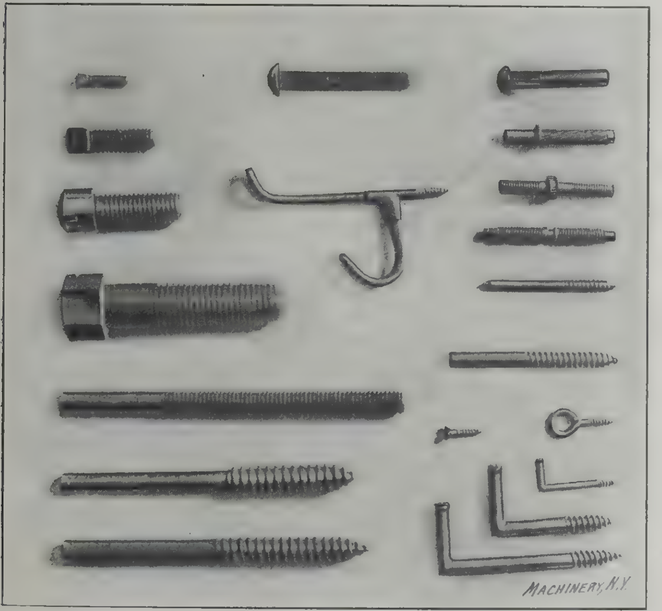


Fig. 8. Examples of Work performed in Thread Rolling Machines

diameter where the thread is to be formed.

The fact that thread rolling is accomplished without waste is perhaps a consideration worth taking into account.* Suppose that we are threading ¾-inch bolts, the threaded part being 4 inches long. When cutting the threads in a lathe or with dies we use full size stock, but when rolling them we can use stock 0.689 inch in diameter. The saving is expressed by the formula:

$$S = \frac{\pi}{4}(G^2 - g^2)\, l$$

in which G is the diameter of the finished thread, g the diameter of the blank, and l the length of the thread. For the example above, we find:

$$S = 0.7854\ (0.750^2 - 0.689^2) \times 4 = 0.276 \text{ cubic inch.}$$

For 10,000 bolts we would have a saving of 2,760 cubic inches, or about 770 pounds of steel.

* The bolts for holding together the cast-iron sections of the Hudson tunnel tube are all provided with rolled thread.

Quite aside from the question of economy of material is that of the quality of the product. A bolt or screw whose threads have been rolled may not be suited to applications where microscopic accuracy of the threads is essential; no one would think of using a rolled thread for a micrometer screw. The strength of the thread, however, appears to be fully that of cut threads, although the writer is not aware of any extended comparative tests having been made between cut and rolled threads. It seems reasonable to expect even greater strength from these threads for the reason that the rolling process, executed on cold metal, may be expected to impart firmness to the thread and adjacent parts.

One of the greatest advantages of the manufacture of bolts and screws by the rolling process is the rapidity with which the work can be carried out. The smallest machine manufactured by the Waterbury Farrel Foundry & Machine Company, for instance, having a capacity of stock up to 3/16 inch in diameter, will roll screws at the rate of one every 4/5 of a second. If the thread is short, this speed, it is claimed, can be increased. The largest machine, having a maximum capacity of blanks 1½ inch in diameter, is said to be capable of rolling threads at a rate of one every three seconds. In Fig. 6 is shown a medium-sized thread rolling machine provided with the automatic feeding device illustrated in Fig. 3. As shown in the half-tone, the center-plate is at the highest point. The toothed wheel arrangement for removing blanks improperly caught by the center-plate is barely visible over the edge of the hopper. The fixed die is on the side toward the observer, the movable die being mounted in a slide having guides at top and bottom as indicated. In Fig. 7 is shown a larger machine which is not provided with an automatic feeder.

In Fig. 8 are shown a number of screws and other pieces of work having threads produced by rolling. Among these samples is a wood-screw with tapering thread and gimlet point. In other samples the thread is straight until near the end, where a gimlet form is produced. Attention may be directed to the longitudinal grooves on two of the pieces at the top of the illustration. While these are not threads in the ordinary sense, although they might be regarded as groups of multiple threads with an infinite lead, they may be readily formed by a rolling operation. Another sample shows a thread with a very steep lead. Pieces with a threaded portion at each end, one right-hand and the other left-hand, are also shown. That it is practicable to thread very close up to the head may be seen from some of the samples to the left.

* * *

THE "NEW MECHANICS"

In an address before the French Association for the Advancement of Science, Mons. Henrie Poincaré recently pointed out the contrast between the so called "new mechanics" and the old mechanics based upon Newton's laws of motion. The conceptions of the new science of motion are not easily presented in a popular form, because of their entire novelty. In a word, the modern idea is that a constant force acting upon a moving body does not impart equal increments of velocity in each successive second, but that the accelerative effect decreases as the velocity of the body becomes greater, and finally reaches a limit which it cannot pass. This limit is the velocity of light. In other words, the inertia of matter increases with its velocity of translation, and becomes infinite when the velocity is equal to that of light. Another form of statement is that the mass of a material body increases with its velocity of movement, and that there can be no motion swifter than that of light, that is, about 186,330 miles per second.—*Youth's Companion.*

* * *

CORRECTION

In the articles "Machining Cylinders and Pistons for Automobile Engines" and "Automobile Factory Practice," January number, engineering edition, it was stated that in the Nordyke & Marmon shops pistons are lapped in dummy cylinders, using oil and emery. This is an error as regards the abrasive. Powdered glass is used instead of emery on account of the well-known tendency of emery to embed in cast iron and cause destructive wear in use.

MACHINE SHOP PRACTICE*

THE VERNIER SCALE—ITS PRINCIPLE AND METHOD OF READING

Every machinist knows how confusing it is to take measurements with a scale that is graduated in hundredths or even sixty-fourths of an inch, owing to the multiplicity of lines. If it were possible to graduate a scale to thousandths, that is, so that every inch would be divided into a thousand equal parts, it would, of course, be useless, owing to the extreme

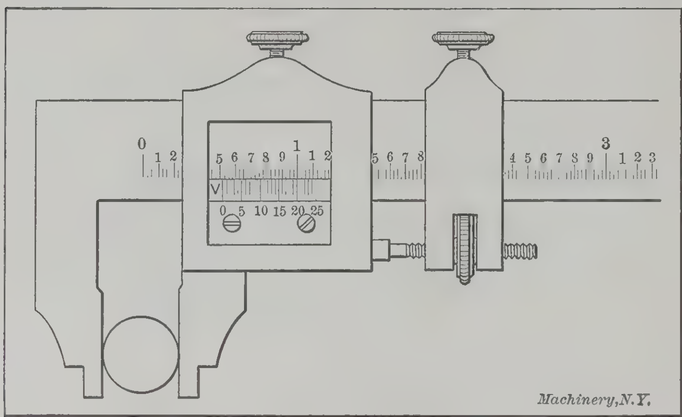
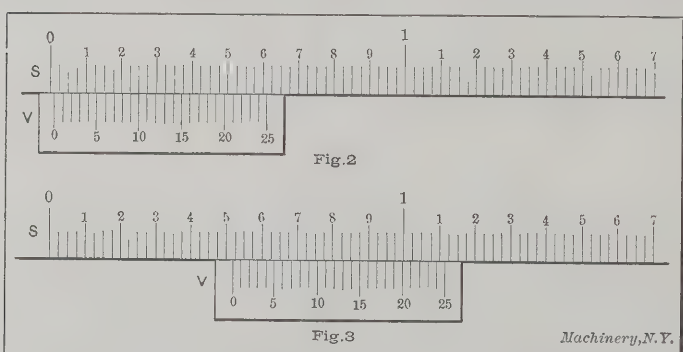


Fig. 1. Caliper Square with Vernier reading to Thousandths

fineness of the lines and the minute distances between them. Such fine divisions on a scale are not, however, necessary, for by means of a special auxiliary scale called a vernier (after its inventor), graduations which are comparatively large can be divided so that fine measurements may be taken. For example, the true or regular scale of the caliper-square shown in Fig. 1, is graduated in fortieths of an inch; but by means of the vernier scale *V*, which is attached to the sliding head of the instrument, measurements within one-thousandths of an inch may be taken. In other words, the vernier, in this case, makes it possible to divide each fortieth of an inch on the true scale into twenty-five parts. The vernier may be defined, then, as an auxiliary scale that is attached to caliper



Figs. 2 and 3. Scales with Verniers set to Different Positions

squares, protractors, etc., for obtaining fractional parts of the sub-divisions of the true scale of the instrument.

By referring to the enlarged scales shown in Figs. 2 and 3, the principle of the vernier can be more easily understood. Here each inch of the true scale *S* is divided into ten parts, and each tenth into four parts, so that the finest divisions are fortieths of an inch. The vernier scale *V* has twenty-five divisions, and its total length is equal to twenty-four divisions on the true scale, or 24/40 of an inch; therefore, each division on the vernier equals 1/25 of 24/40 or 24/1000 inch. Now, as 1/40 equals 25/1000, we see that the vernier divisions are 1/1000 inch shorter than those on the true scale. If, then, the zero marks of both scales were exactly in line, the two first lines to the right would be 1/1000 inch apart; the next two 2/1000; etc. It is evident then that if the vernier be moved to the right until, say, the tenth line from the zero mark exactly coincides with one on the true scale, as shown in Fig. 2, the movement will be equal to 0.010 inch, since this line was 0.010 inch to the left of the mark with which it now coincides, when the zero lines of both scales were together. Similarly, if the fifteenth line were exactly opposite a line on the true scale the movement of the vernier would be equal to 0.015, etc.; so we see that the number of thousandths that the vernier zero has moved past a graduation on the true scale, is determined simply by counting the number of spaces between the zero of the vernier, and that line on it which is exactly in line with one on the true scale. If the vernier were moved along to the position shown in Fig. 3, the true scale would indicate directly that the reading was slightly over 0.500 inch, and the coincidence of the graduation line 15 on the vernier with a line on the true scale, would show the exact reading to be $0.500 + 0.015 = 0.515$ inch; that is, the exact amount (in thousandths with this particular vernier) that the vernier zero has moved past the 0.500 division, is determined, as before stated, by counting the spaces between vernier zero line and that line of the vernier which coincides with one on the true scale.

In Fig. 4 a true scale *S* is shown that is graduated into sixteenths of an inch, and the vernier *V* has eight divisions with a total length equal to seven divisions on the true scale, or 7/16 of an inch; therefore each division on the vernier is 1/8 of 1/16, or 1/128 inch shorter than the divisions on the true scale; so we see that in this case the vernier enables readings to be taken within one-hundred and twenty-eighths of an inch instead of in thousandths as with the one described in the preceding paragraph. The divisions then that may be ob-

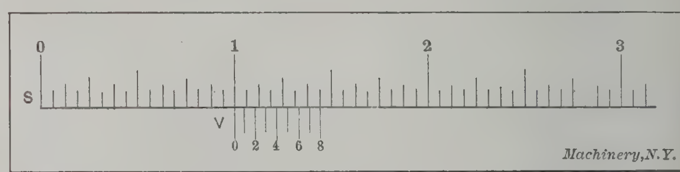


Fig. 4. Scale with Vernier Reading to One-hundred Twenty-eighths of an Inch

tained by a vernier depend altogether on the way the true and vernier scales are graduated. In order to determine the fractional part of an inch that may be obtained by any vernier, multiply the denominator of the finest sub-division of an inch given on the true scale, by the total number of divisions on the vernier. For example, if as in Figs. 2 and 3, the true scale is divided into fortieths and the vernier into twenty-five parts, the vernier will read to thousandths, as twenty-five times forty equals one-thousand. If there are sixteen divisions to the inch on the true scale and a total of eight on the vernier (as in Fig. 4) the latter will enable readings within one-hundred twenty-eighth of an inch to be taken, as eight times sixteen equals one hundred twenty-eight. It will be seen then that each sub-division on the true scale is divided into as many parts as there are divisions on the vernier. If, for example, the vernier of a protractor has, in all, say twelve divisions, evidently each degree may be divided by it into twelve parts or one-twelfth degree. As there are sixty min-

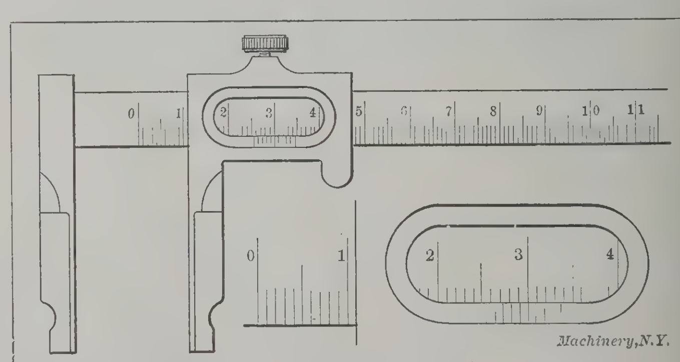


Fig. 5. Caliper Square Graduated on the Metric System

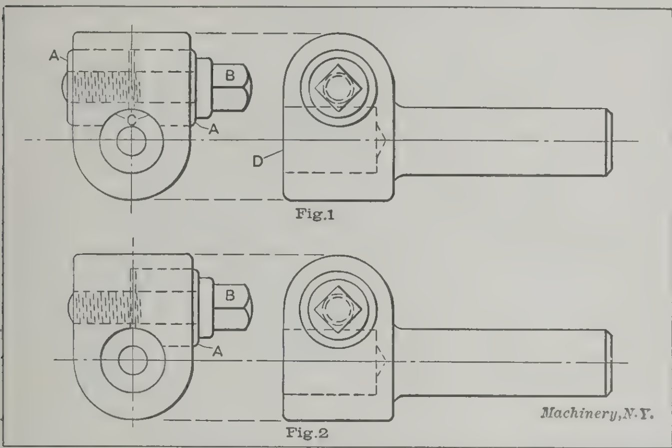
utes in one degree, the protractor would indicate angles within five minutes.

The following is a general rule for taking readings with a vernier: Note the number of inches and whole divisions of an inch that the vernier zero has moved along the true scale, and then add to this number as many thousandths, or hundredths, or whatever fractional part of an inch the vernier reads to, as there are spaces between the vernier zero and that line on it which coincides with one on the true scale.

* With Shop Operation Sheet Supplement.

For example, the zero line of the vernier shown in Fig. 1 is slightly beyond the 0.500 division, and graduation line 15 on the vernier coincides with one on the true scale; hence, the reading is 0.500 + 0.015 equals 0.515 inch. If the vernier is attached to a protractor, note the whole number of degrees passed by the vernier zero mark, and count the spaces on the vernier as before. If the vernier indicates angles within five minutes the number of spaces times 5 will, of course, give the number of minutes to be added to the whole number of degrees.

The application of the vernier to a "Columbia" caliper-square graduated on the metric system, is illustrated in Fig. 5. Here we have, instead of inches, centimeters which are sub-divided into ten parts called millimeters. By the aid of the vernier, each millimeter is again divided into ten parts so that readings can be taken to within 1/10 of a millimeter or 1/100 of a centimeter (0.0039 of an inch). The reading with the caliper set as shown in the illustration is 2 55/100



Figs. 1 and 2. Turret Lathe Tool-holders of the Double and Single Binder Type

centimeters, or, as commonly expressed, 25 5/10 millimeters. This particular instrument has on the opposite side of the beam two series of inch graduations which, with the verniers, enable measurements within 1/100 and 1/128 of an inch to be taken. It will be seen that inches may be converted into metric measurement, and *vice versa*, by taking the reading first on one side of the beam and then on the other.

Further information on reading verniers when applied to a micrometer or bevel protractor is given in the Shop Operation Sheet accompanying this number, to which the reader is referred.

* * *

The education of apprentices at the United Shoe Machinery Co., Beverly, Mass., has been arranged along lines similar to those in vogue in Worcester and Fitchburg, and which have previously been mentioned in MACHINERY. The company has organized two classes of twenty-five boys each, recruited from the machine tool department. The city has a technical school supported by the town and the state board of industrial education, and the two classes of boys work alternate weeks in the shop and in the school. These boys are paid half the piece rates that the regular factory employes are paid, and earn at an average of $3 per week, although a few of them earn $5 weekly. Besides these small earnings, of course, they get a thorough knowledge of the use of machinists' tools and, in fact, learn the entire machinist's trade. The class when instructed in the school is taught such subjects as drawing, elementary machine design, mathematics and other practical subjects. They do not receive any pay while attending the school. There is no effort made to educate the students to be superintendents or foremen, but they are fitted to earn a livelihood, and, as one of the men in charge at the Beverly factory says, "If they have the right stuff in them they will get there."

* * *

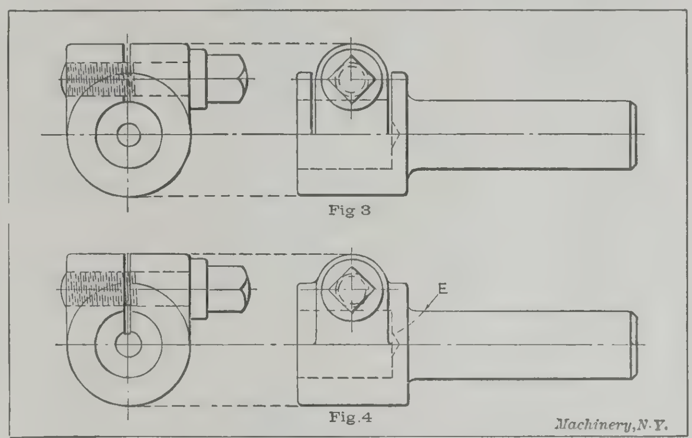
The *Mechanical World* states that aluminum may be etched by the following etching fluid: alcohol, 4 ounces; acetic acid, 6 ounces; antimony chloride, 4 ounces, and water, 40 ounces.

TOOL-HOLDER DESIGNS

F. P. CROSBY*

A number of tool-holders of different designs for turret lathe and automatic screw machine work are shown in the accompanying illustrations. As many of the types illustrated are widely used and represent standard practice, they are presented herewith for the guidance of tool-makers, designers, or others interested in such equipment.

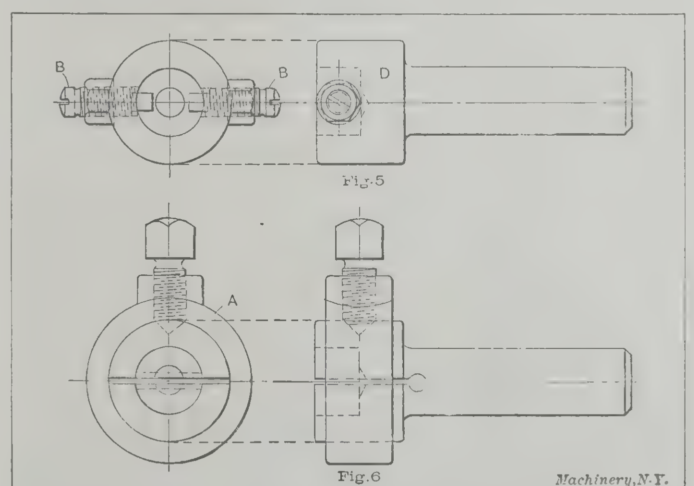
The binder type of turret lathe tool-holder is shown in Figs. 1 and 2. Fig. 1 illustrates a holder of the double binder type. The hardened cylindrical parts *A*, which should be fitted accurately to the body of the holder, serve to clamp the tool in place. These parts are turned away at *C* to conform to the hole in which the tool is inserted. As may be seen, one of these parts is tapped to fit the screw *B*, which has a collar head bearing against the other part. The clamping action is effected by turning screw *B*, which draws the two parts *A* together, thus binding them firmly against the cutter which



Figs. 3 and 4. Two Tool-holders of the Compression Type

is inserted in the bore *D*. The holder shown in Fig. 2 is of the single binder type. The screw *B* is tapped into the body of the holder and only one binding piece *A* is used. These holders are considered to be the best of their class and they can, of course, be made in any size that may be desired. The construction is clearly shown in the engraving.

Figs. 3 and 4 show two holders of the compression type, which for some classes of work is the best. These two holders are practically the same, differing only in the way they are split to obtain the required amount of elasticity for clamp-



Figs. 5 and 6. Holder for Short Tools with Different Methods of Clamping

ing the tool. The holder shown in Fig. 3 is split both across and lengthwise, while the other holder has a single slit lengthwise as far back as *E*. The clamping screws for each tool are only tapped into one-half of the body, so that when they are turned, a clamping action takes place.

Two forms of shallow holders for short tools are shown in Figs. 5 and 6. The taper-point screw style is shown in Fig. 5, the clamping screws *B* being pointed to an angle of three

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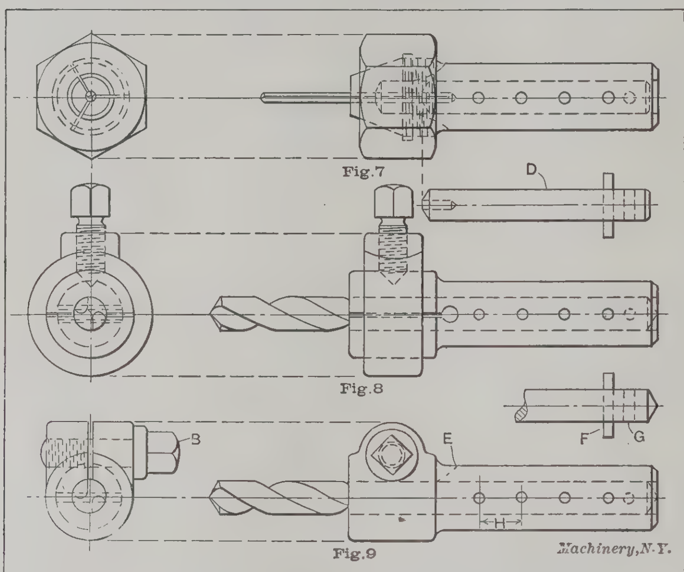
degrees and fitting into holes drilled in the tool shank. These holes are located at the right distance from the end so that the screws bind the end of the tool shank against the holder. The holder shown in Fig. 6 is of the compression type, the split end being tightened on the tool shank by the collar *A* and pointed screw shown.

Drill holders of the compression type are shown in Figs. 7, 8 and 9. Fig. 7 shows a compression holder of the chuck type which is used for holding small drills. The shank of the drill is soldered to a larger shank, which has a retaining pin engaging the holes in the holder. This enlarged shank, that the small drill is soldered to, is shown in detail at *D*. The small hole in the end for the reception of the drill is plainly indicated by the dotted lines. The holder shown in Fig. 8 is provided with a collar and pointed screw for clamping the drill. With the exception of the method of clamping, this tool is similar in other respects to the one shown in



Figs. 7, 8 and 9. Three Types of Drill Holders

Fig. 9. The latter is slotted lengthwise as far back as *E*, and the drill is held in position by the collar-head clamping screw *B* which is tapped into one side of the holder. The shank of this holder has drilled into it a number of holes in regular order as shown. The shank of the drill is fitted with the pin *F*, which prevents the crowding back or turning of the drill in the holder. An extra hole *G* is provided for the pin,

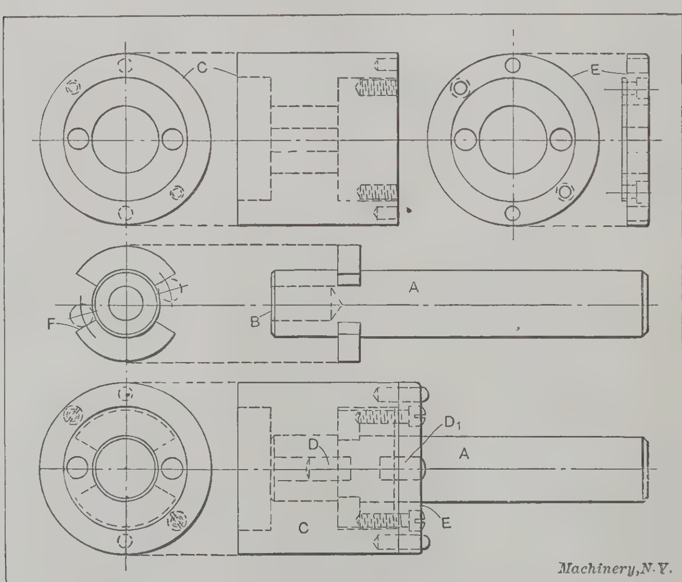


Fig. 10. Assembled and Detail Views of a Die-holder

and the distance between the two pin holes is equal to one-half the dimension *H*. The clamping screw on a holder of this type needs only to be tightened enough to bring the tool in line.

Fig. 10 shows both assembled and detail views of a solid shank die-holder. The reference letters used in the detail views are the same for the corresponding parts in the assembled view. The shank and the clutch *A* is made in one piece from tool steel, and it is tempered and ground. In the end of this shank there is a clearance hole *B*, the depth and diameter of which is sufficient to give the required clearance for the work. The sleeve *C*, which is accurately fitted to the shank,

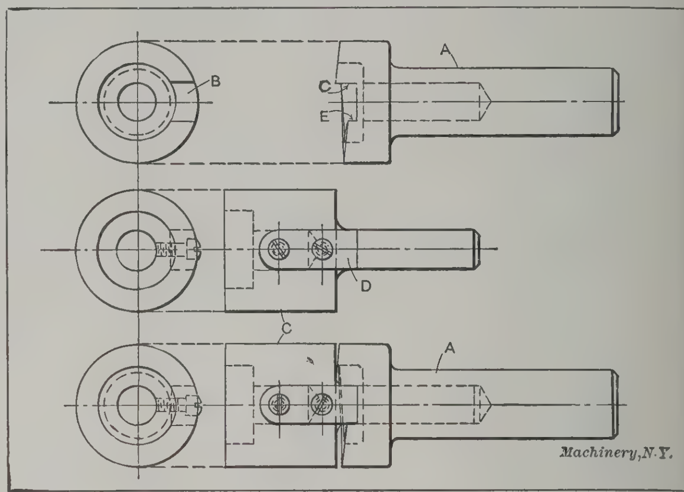


Fig. 11. Another Type of Die-holder

has attached to it the die, two of the contact pins *D* for driving the die, and the backing-off plate *E* with its contact pins D_1. The way in which the backing-off plate is held in place by screws and dowels is clearly shown in the illustration. The contact points at *F*, in case the shank should become worn, can be trued by grinding. The contact pins in case of wear can be removed and turned one-quarter way round.

A die-holder of the semi-hollow shank order is shown in Fig. 11. The shank *A* of this holder should be made of tool steel tempered and ground. On the enlarged end of the shank is shown a left-hand helix which is cut from the slot *B*. If the holder is to be used for cutting a left-hand thread, a right-hand helix has to be provided. The die is held in the

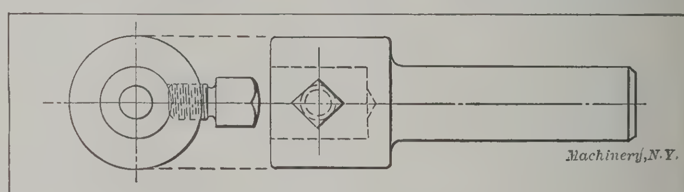


Fig. 12. Tool-holder of Objectionable Design

swiveling part, *C*, which is fitted to the shank as shown. In operation, when the turret comes to a stop, the clutch *D* disengages with the point *E*, and in backing off it is in contact with the point *C*. The clutch is made of tool steel, and is tempered and fitted to the die-holder in a manner clearly indicated in the illustration.

The tool-holder shown in Fig. 12 is one in common use, but the best place to put it is in the scrap pile, as it is simply impossible for any workman to adjust a tool in it that will be lined up properly. It is supposed that the reason for using this type of holder is to save a little on the cost. Such a tool, however, will prove to be a very poor investment.

* * *

According to the provisions of the new custom tariff of Norway, machines, motors and apparatus not manufactured in the country will be admitted free of duty. As the machine industry in Norway is comparatively undeveloped, there are a great many machines and machine parts which are thus placed on the free list, among which may be mentioned band saw blades, circular saw blades, steam hammers, pneumatic drills, steam turbines, ball bearings, link belts, etc. The complete list of the machinery admitted free of duty may be found in the November 19, 1909, issue of the *Daily Consular and Trade Reports*, published by the Department of Commerce and Labor, Washington, D. C.

* * *

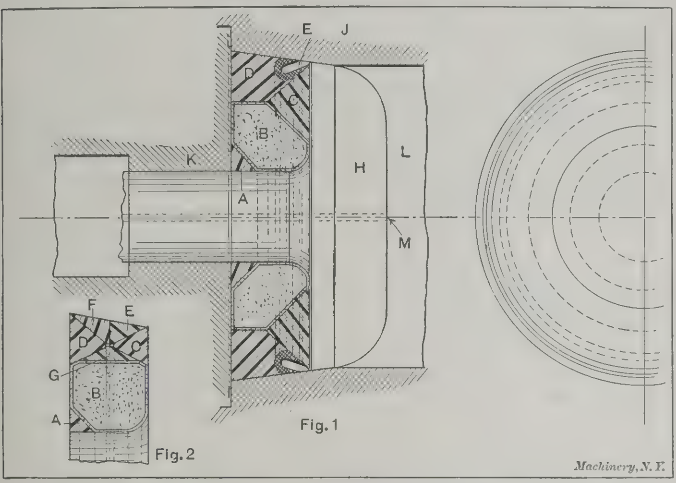
Don't forget that the top of a work-bench should slant back toward the wall.

A GAS CHECK FOR BIG GUNS

ROBERT O'NEAL

In the large guns in use by the government, as in most other things, it is the little parts that make the great engines of war of real value. This is clearly illustrated by the fact that a fifty-thousand dollar implement of modern warfare may be temporarily put out of commission by the catching on fire of a small pad used in the construction of what is known as the gas check. This little pad which is made of canvas, hair, tallow, beeswax, etc., is worth about thirty cents, which is an insignificant sum when compared with the cost of the gun, complete; but the gun without it is about as dangerous at one end as at the other.

In Fig. 1 of the accompanying engraving is shown, in cross-section, the interior of that part of a large gun with which this little pad has to do, and in Fig. 2 the present method of the construction of the rings of a gas check is illustrated. The difference between the two checks is clearly perceptible, and the advantage of that shown in Fig. 1 over that of Fig. 2 will, I think, be readily seen when the matter is fully explained.



Sectional View of Gas Check for Big Guns

In order to show as clearly as possible the use of the rings and the pad, it will be necessary to go into the matter somewhat in detail. In Fig. 1, *H*, *J*, *K*, and *L* represent the mushroom, the gun, the breech-plug and the powder or combustion chamber, respectively. When the charge is rammed home, the breech-plug—the face of which is shown in contact with the rear face of the rings *A*, *D*, and the pad *B*—is swung into position and turned through an arc of 40 degrees, it having entered an interrupted thread of sixty one-hundredths inch lead; this brings the mushroom *H* firmly against the wall of the gun *J*, through the contact of the rings *A*, *C*, *D*, and the pad *B*. Now, the powder charge in the chamber *L* is ignited through the vent *M*, and a pressure ranging anywhere from forty to fifty thousand pounds per square inch is generated within the chamber. Against this pressure it has been found impracticable to devise a method of holding the mushroom *H* sufficiently hard against the wall of the gun to prevent the escape of gas; therefore the gas check is necessary, as the mechanism must be free-working to allow of easy manipulation by the gun crew.

As the mushroom moves back, the pad *B* is caught between the members *A* and *C*, and as *C* is held rigid, the tendency is to reduce the thickness of the pad *B* and increase its diameter. This directly increases the diameters of the rings *C*, *D*, *E*, *F* and *G* when they are constructed as in Fig. 2, and brings them up against the wall of the gun with a pressure directly in proportion to the pressure of the gases in the combustion chamber, according to the laws of force as applied to the wedge; but this increased diameter is accompanied by a proportionate increase in the opening where the ring has been cut. The opening necessary for this expansion, though small (about 0.006 of an inch), like most little things, plays an important part, in that it allows the gas to escape through it to the pad *B*. As the temperature of this gas is that of a white heat, and acting under a pressure sufficient to throw a five-hundred-pound projectile about twelve miles in something less than half a minute, it is safe to say that this little mass of combustible substance can not long resist the onslaught of such a potential factor of destruction. Quite often only one charge is fired, when it is found necessary to renew the pad, and rarely can over three or four shots be made without renewal. While this does not require any great amount of time, nevertheless, it requires the removal of the firing lock (not shown here), the mushroom, and the dismantling of the rings; in addition the danger of fire in the turret is incurred while removing the burning pad.

It will be seen at a glance that the difference between the two gas checks illustrated lies principally in the construction of the ring *E*. In Fig. 2 this ring is of triangular cross-section and of solid metal, necessitating its being cut in order to increase its diameter when the gun is fired. In Fig. 1 ring *E* is of a U-shape in cross-section, which will allow of its being opened out to fill the space between the angular face of the ring *C*, and the wall of the gun, without cutting it, for, when the mushroom *H* recedes, the ring *C*, being solid, is carried back with it; the pad *B*, in either case, is pressed thinner and consequently larger in diameter, thus forcing the ring *D* out and hard against the wall of the gun. The gas, passing between the mushroom *H* and the wall of the gun *J*, is caught between the legs of the U-shaped ring *E*, which is being firmly supported on its inner side by the face of the ring *C* and on the outer side by the wall of the gun, while the round portion is sustained by the concave surface of the ring *D*. The pressure of the gas forces the legs outward against these three surfaces with a pressure equal to that within the chamber, and a joint is made between these surfaces through which the gas cannot possibly escape.

This design of check could be constructed to take the place of the one now in use without in any way altering the standard parts of the gun, as the set of rings shown in Fig. 1 could be made to fill the space occupied by the set shown in Fig. 2; and, if constructed with care, I see no reason why they would not last as long as the gun, or, at least, until general repairs are needed, which is usually after approximately fifty shots have been fired.

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* * *

KINDLINESS AN ASSET IN MANUFACTURING

It may seem a long step from machine construction to the sentimentalism of smiles and kind words, but nevertheless these two items play an important part in many successful manufacturing plants. The object sought by a manufacturer is efficiency—efficiency on the part of the individual members of the organization as well as on the part of the machinery employed. A great deal of time and thought is expended on making the machinery efficient. Experiments are made, careful records are kept, and the best results utilized; but little thought is usually given to increasing the efficiency of the "man who works with his hands," and that often lacks system and appreciation of the final effect. Sometimes attempts are made to increase the efficiency of the men making up the organizations by methods entirely erroneous, not to say culpable, and which in the long-run prove as costly as they are ineffective.

There is, however, an inexpensive method of increasing the efficiency of the personnel in any organization. While fair compensation, and what is generally considered fair treatment are absolute essentials, a great deal can be both lost or gained by the general attitude of the employers and men in charge of the various departments. A kind word, an appreciative smile, a commendation for work well done, for instance, will often increase the efficiency, and are more effective in eliminating friction, than a so-called welfare department planned on an elaborate scale.

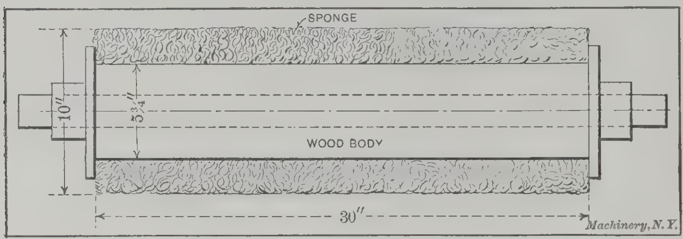
The efficiency of the mechanical element of the industries has been raised to a high standard, and the efficiency of the human element should be raised to an equal height by methods which will be of lasting effect both in a factory and without. If you never use smiles and kind words, try them, and you will find that the effect will be immediate, not only on those around you, but on yourself.

LETTERS ON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

INGENIOUS METHOD OF TURNING A SPONGE-COVERED ROLL

A roll formed of strips of sponge and a wooden body, had to be turned true, and the writer was asked to do the job, which was wanted in a hurry. You can bet that there was some question as to how it was to be done. The sponge strips were fastened by brass tacks to the wooden body. These tacks were placed as near together as possible, there being about sixteen of them to each block of sponge. After the roll was built up in this way, the method of getting it to the required diameter proveu to be a sticker. There were enough suggestions offered to fill a book, but finally the following method was tried with considerable success. As the temperature out-of-doors was near the zero mark, the roll was placed outside on two wooden horses with blocks arranged on either side of the shaft so that it could be turned. With the aia of a dog on one end of the shaft, the roll was then revolved, while a fine spray of water from a hose was turned on it. In about twenty minutes the roll was frozen solid; it was then placed in the lathe and two cuts were taken over it, which completed the job. After the ice melted, the sponge covering was found true.

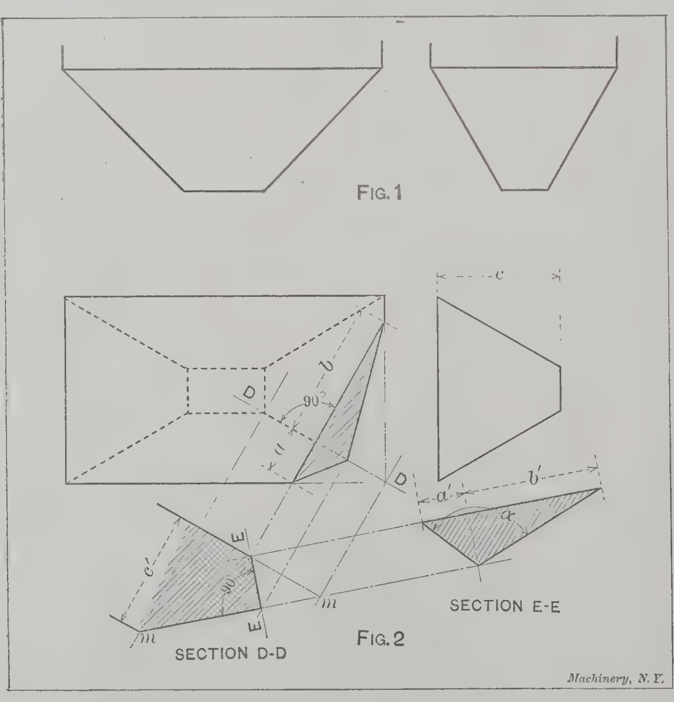


Wooden Roll with Sponge Covering which had to be turned true

Lewiston, N. Y. CHARLES H. LAKE.

ANGLES OF HOPPER SIDE INTERSECTIONS

In building a steel hopper of the form shown in Fig. 1, it becomes necessary to know what angle the sides of the tapered portion make with each other, in order to properly bend the flange or splice plate, for the corner, as the case may be. This angle can be obtained graphically, as shown in Fig. 2.



Graphical Method of obtaining the Angle formed by the Tapered Sides of a Hopper

For clearness of demonstration, consider a block of the same shape as the lower portion of the hopper, with a corner cut off in a plane perpendicular to the corner *D-D*, as shown. To obtain the angle, first lay out a plan of the outline of the block as it would be before the corner was cut off; then draw section *D-D*, making *c′* equal to *c*. Draw any line *E-E*, perpendicular to *m-m*, and then projecting upward, obtain a plan view of the surface *E-E*, or a view representing the block as it would appear from above, with the corner cut off. Now draw section *E-E* making *a′* equal to *a* and *b′* equal to *b*. Then *a* will be the required angle. CHAS. E. EVANS.

Aurora, Ill.

[The diagrams of the Data Sheet for April, 1908, will be found very convenient for obtaining the angle formed by hopper sides.—Editor.]

MILLING A CORRECT BEVEL GEAR

In this article a method of cutting bevel gears is described which has been in use now for about two and a-half years, in a number of shops in this vicinity.

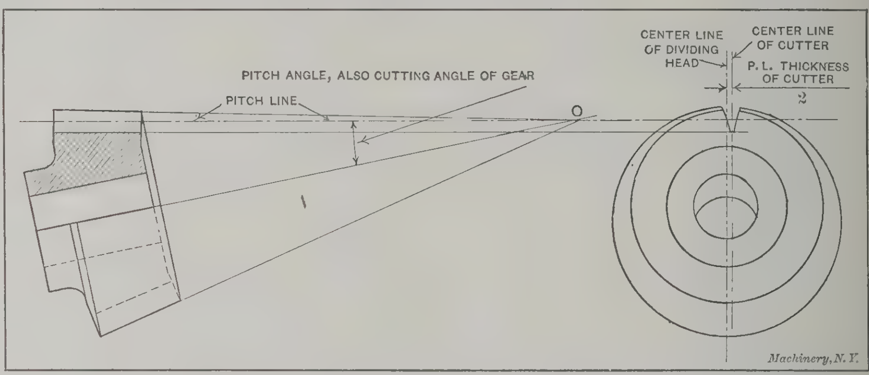


Illustration showing Method of Setting Gear Blank with Relation to Cutter

While the method is perhaps a trifle difficult to understand, as it was to work out, the results are so satisfactory as to more than make it pay. It is applicable to all cases excepting miters of very coarse pitch and few teeth and where strength is an essential feature. There is a slight excess depth at the small end of the tooth which, ordinarily, is entirely negligible and only in unusual cases is so objectionable as to make this process impracticable.

The advantages sought for and gained are these: A smooth-running bevel gear milled scientifically without "cut-and-try"; a pair of bevel gears which mesh perfectly at the pitch-line; a bevel gear which requires no filing at the small end of the tooth to make it run smoothly; and, as important as anything, a method that saves a large amount of time and does away with uncertainties in bevel gear cutting.

PITCH LINE THICKNESS OF B. & S. BEVEL GEAR CUTTERS

Diam. Pitch	2	3	4	5	6	7	8	10	12	14	16	20
Thickness	.513	.334	.257	.204	.169	.145	.126	.100	.082	.070	.060	.047

These results are accomplished as follows: The regular bevel gear cutter is used. The gear to be cut is mounted as usual in the dividing head, but it is set up so that the working or pitch angle of the gear is the cutting angle; in other words, so that the pitch line of the tooth running to the common center *O* of the gears is parallel with the bottom of the cut, as shown in the accompanying illustration. The milling machine table is not swivelled in any case.

The cutter is set for depth, as usual, from the high point on the gear to be cut. The saddle of the machine is moved so that the vertical center of the cutter is to one side of the vertical center of the gear, a distance equal to half the pitch line thickness of the cutter. A cut is then taken all around, for each tooth. This finishes one side of the tooth. The

other side of the tooth is finished by moving the saddle in the opposite direction, so that the vertical center of the cutter is on the opposite side of the vertical center of the gear, a distance equal to half the pitch line thickness of the cutter as before. Before the cut is taken the dividing head spindle is rotated so that the amount taken off this opposite side of the space is such as to leave a tooth of the correct thickness at the back, which may be easily determined by trying a spur gear cutter of the same pitch and number of teeth, or tooth gage, or spur gear tooth of the same pitch, or otherwise. This being done, the cut is taken all around, which finishes the gear.

On examination, by actual test, careful measurements or analysis of the method, it will be found that the results sought have been secured and the gears will run proudly, as self-respecting bevel gears ought to run.

Muskegon, Mich. CHAS. A. KELLEY.

INTERESTING WORK IN AN EXPERIMENTAL SHOP

No one class in society has a corner on inventive genius; to-day, the doctor conceives the "best thing yet," while on

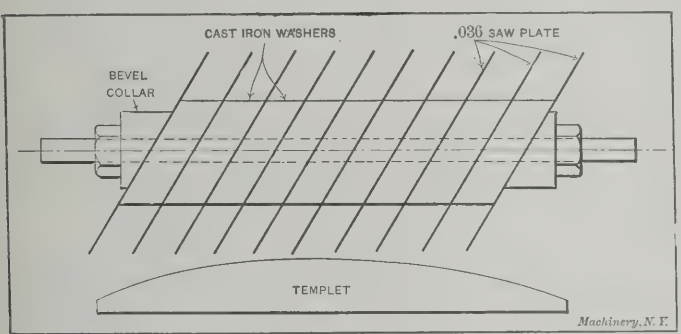


Fig. 1. Steel Disks which were turned to conform to the Templet

the morrow the chances are that it will be the laborer who is propounding something that will bring him fame and fortune. The machine shop has been and will continue to be the mecca of inventors, and a shop catering to experimental work is brought face to face with constructions and schemes as diversified as are the stations in life of their sponsors. To save the inventor from being "stung" for special tools and fixtures which he is sure will be needed when he gets to the manufacturing stage, the shop man may have to use diplomacy, and then, on his own side, resort to some homely short cuts to get the work through without these special tools.

Figs. 1 and 2 show pieces of work turned out for different

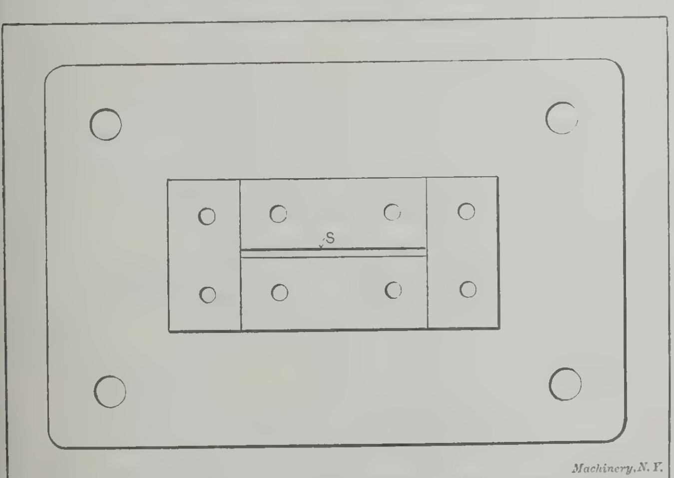


Fig. 2. Four-piece Die for Experimental Work

inventors (each with plenty of money to spend) at a fraction of the outlay that might have been put upon them. The mandrel in Fig. 1 was loaded with carbon steel disks that had to be turned to fit a templet. These disks, instead of being at right angles to the center line of the mandrel, were at an angle as shown, an effect produced by using a beveled collar on each end and loose fitting spacers between the disks. It can readily be seen that to turn these disks, projecting beyond the spacers from 3 to 5 inches, was impossible by ordinary means unless a rigging was made to follow in and out and back and forth as each one was cut separately—all of which was practically out of the question. The short way out of it was to slip on each end of the mandrel a board the size of the largest disk blank and to wrap about the whole several thicknesses of heavy manilla paper and tack it securely to the boards. After filling the disks with lead both the lead filler and the disks were turned off to the shape of the templet in quick time.

Fig. 2 shows a die and block that were substituted for the inventor's specifications for a solid tool steel die with a slot *S* 3/32 by 3 inches and absolutely to size. The four-piece die illustrated was simple to make as compared with the solid one, had ample security against spreading when set into the block, could be sharpened as often as necessary, maintained its size, and presented no risk in hardening.

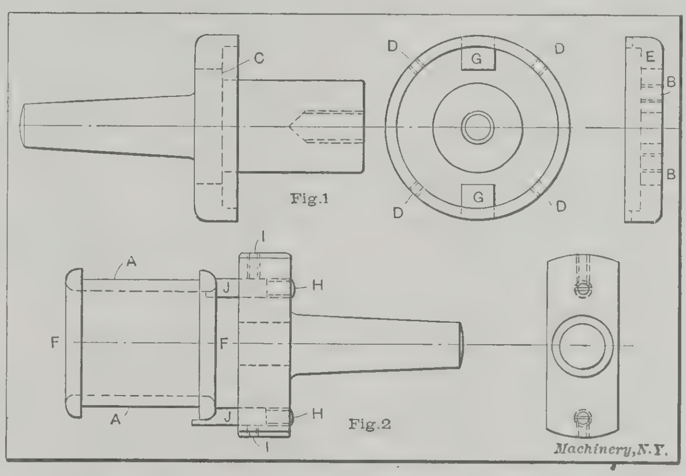
And like so many that have gone before, neither of the above pieces was ever used long enough to keep the rust off and neither produced dividends on the investment.

Middletown, N. Y. DONALD A. HAMPSON.

MACHINING SPLIT BEARINGS

An interesting problem in the machine shop is to bore and and turn split bearings accurately. The success obtained by the use of the following methods, leads me to sumbit them to the readers of MACHINERY. The bearings are made of brass; when received from the foundry, they are placed in a shaper and planed on the faces *F-F* to a certain height from the back. After this operation, they are taken to the forge and sweated together. While this is not absolutely necessary, it facilitates handling the work in the next operation of chucking and boring.

The brasses are held by a pair of false jaws, which were cast



Mandrel on which Bearings are turned, and Special Tool used for Rounding Corners

for the turret lathe, and which are turned and recessed so as to clear the flange of the brass and bear on the faces *A*. The boring is done with a bar and fly-cutter, the bar being supported by a bushing in the spindle of the machine. The front face and flange are next squared and turned off before the work is removed from the chuck. It was to shorten the time required and facilitate the operation of turning the brasses that the mandrel shown in Fig. 1 was designed. The shank was made to fit in the headstock; and as the mandrel is very rigid, it is not necessary to support it by the tailcenter; consequently, high speeds can be used and there is no danger of a center becoming heated. The brasses are placed on the mandrel with the end previously finished in the turret lathe against the finished face *C*. They are locked in place by four set-screws *D*. A C-clamp is placed on the outer end of the brasses and is left there until that end and flange are finished. The cap *E* is then placed over the outer end of the brasses and the clamp is removed. This cap is fastened to the mandrel by a bolt in the center. Set-screws are provided in holes *B* to aid in removing the cap, as it is made a snug fit over the work, to prevent the latter from spreading during the process of turning. The over-all measurements are taken

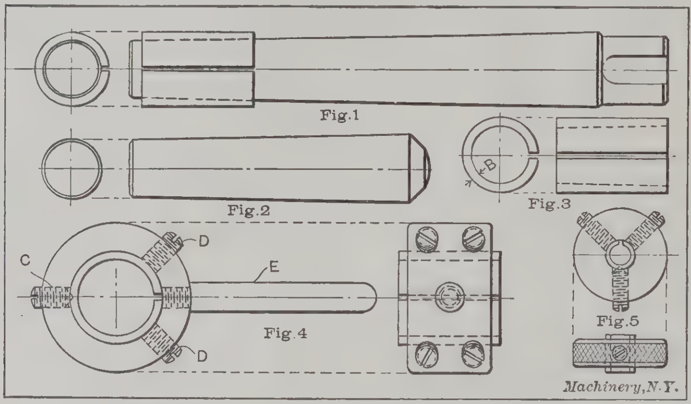
through the port-holes *G*, which are cut in the mandrel for this purpose.

After the trial lot of brasses had been completed, the radius- and fillet-turning tool, shown in Fig. 2, was designed. This tool is held by a shank in the tailstock and with it the corners of the bore and flange are rounded with a greater degree of accuracy than is ordinarily obtained when the shape of these surfaces is left to the judgment of the workman. The cutters *J* are made of drill rod, and they may be adjusted by the screw *H* and locked by the screw *I*. Direct evidence as to the time-saving qualities of the foregoing method, was given when the cost clerk made inquiry about the shortness of the time listed on the daily time cards for the lot of work which was machined by these tools.

Salem, Mass. JOHN F. WINCHESTER.

LAPS AND POINTS ON LAPPING

The laps which are shown in the accompanying illustration are excellent designs for both the outside and inside lapping of cylindrical parts. Fig. 1 shows an inside lap with the arbor in place. The included angle of the taper of this arbor should be about 2 degrees; this is considered great enough for any kind of work. The lap proper, or the part that is in contact with the work, is made of bolt copper, and is shown in detail in Fig. 3. Cast iron and lead are sometimes used, but copper is the best metal for hardened work. The lap is split as shown, to allow it to expand as it becomes worn. The length of the lap should be somewhat greater than the length of the hole to be operated on, and the thickness *B* should not be more than 1/6 or less than 1/8 of the diameter of the work.



Laps for Inside and Outside Work

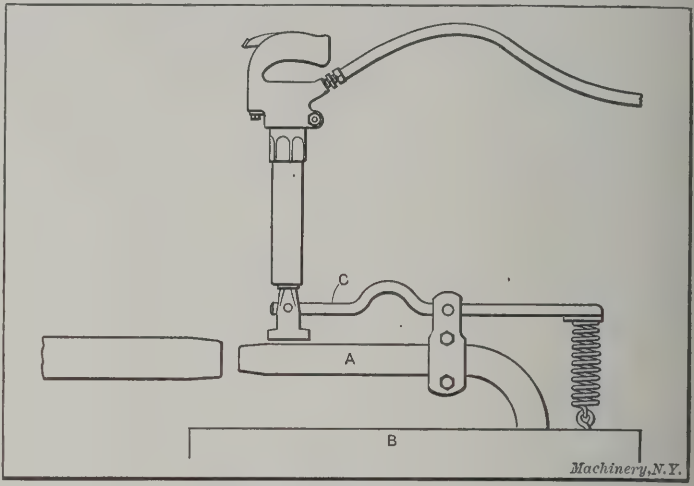
When making these laps, especially small ones, a hardened swedging plug, (Fig. 2) that is ground to the same taper as the arbor, can be used to advantage for tapering the hole through the lap before it is turned and slotted. If in the operation of lapping, the hole becomes "bell-mouthed," that is, enlarged at the ends, this is caused by the introduction of sharp emery from time to time as the hole is being lapped. To obviate this, the lap should be cleaned of all loose emery and expanded by driving the arbor farther into it. The hole is then dry lapped by using only the emery that sticks or is charged in the lap. This process must be repeated occasionally until the proper size is obtained. If the operator is careful to see that the emery used is not too coarse, and the lap is kept expanded to fit the work at all times, the result will be a perfectly straight hole. It takes considerable practice before one can use a lap and keep it from getting lumpy. If this occurs, the high spots must be removed with a file, and the lap kept a close fit to the work. The work should always be finished to size with the lap dry and well fitted to it.

Fig. 4 shows an outside lap. The proportions of the lap proper should be the same as were given for inside laps. The same method of procedure described for inside work should also be followed, *viz.*, the lap must be freed from oil and loose emery from time to time as the work progresses. The pointed screw *C* keeps the lap from slipping out of place, and the adjusting screws *D* compress it to fit the work. A handle *E* should be used on all laps of large size, as it will be found much more convenient than a lathe dog, which some workmen use for moving the lap. Fig. 5 illustrates an outside lap and holder for small work, say less than ½ inch in diameter. Laps of this size are not provided with a handle, but are knurled on the outside as shown. F. P. CROSBY.

Chicago, Ill.

PNEUMATIC FLUE WELDER

An inexpensive flue-welding device that was designed to handle a large repair job that came in unexpectedly is shown in the accompanying illustration. It consists of a mandrel *A*, which is attached to a cast iron block *B*, and a pneumatic ham-



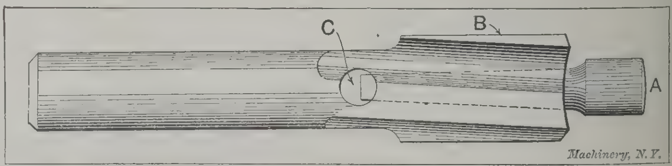
Inexpensive Tool for Flue Welding

mer (equipped with a swage), which is mounted on a lever *C*. As the illustration shows, this arm is fulcrumed to a bracket on the mandrel and is spring supported. The ends of the long pieces were first scarfed by lowering the back end of the tube until it was about six inches below the level of the mandrel. This gave a taper of approximately ¼ inch to the inch. After all the long pieces were scarfed, short pieces about 8 inches long were placed in the furnace and heated on one end so that they could be drawn to a feather edge. This was also done under the pneumatic hammer. After all the flues were scarfed and the short ends made ready for welding, the horse upon which the outer ends of the flues had rested, was raised to bring the work level with the mandrel. All short pieces were then put on the flues while hot so they would shrink tightly in place, thus insuring a good clean weld by preventing any dirt from getting between the surfaces to be welded. After all flues were treated in this way the furnace was cleaned, and the welding done at a speed which would make many of the costly flue-welding machines hustle to keep up with. T. O. MARTIN.

Jackson, Tenn.

COUNTERBORES WITH REMOVABLE PILOTS

By making a counterbore with a removable taper-shank pilot the value and efficiency of the tool is increased fully 100 per cent. Once in a great while a toolmaker is found who makes them this way, but it is not the general practice. The



Counterbore equipped with Removable Interchangeable Pilot

illustration shows very plainly the design we use, excepting for very small sizes. A hole drilled at right angles to, and at the end of the taper, makes the removal of the pilot easy by inserting a drift. Standard taper pin reamers are generally used for reaming the pilot seats, thereby making the different pilots interchangeable within certain limits.

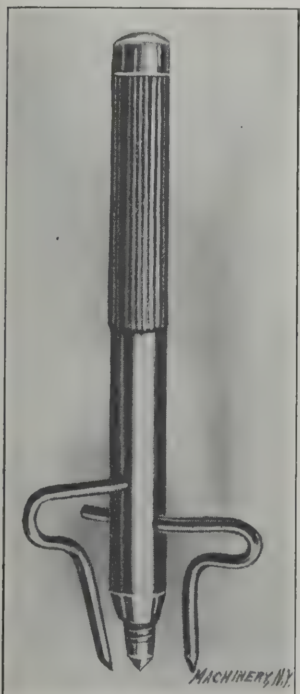
When the matter is carefully considered it is easily seen that a great combination of sizes can be made with but a few counterbores and pilots. Then again, if a pilot breaks when being used (which very often happens with the solid variety), it is but a moment's work to remove the broken part

and replace it with a new one. Last, but not least, is the convenience offered, when sharpening on a grinder, by removing the pilot. The counterbore may be held in a taper collet, if it has a taper shank, or if straight, in a simple form of chuck, fitted to the spindle of the grinder and made straight inside to fit the shank of the tool. The extra cost of the taper hole in the body and turning the pilot, is very slight when compared with the usefulness and long life of counterbores made in this way. A. DANE.

Buffalo, N. Y.

SPACING AND OUTLINING PRICK-PUNCH

By the use of the prick-punch shown in the accompanying illustration, the centers for holes to be drilled within any outline can be located, no matter what the shape, without making extra lines for guiding the point of the punch. For example, if the central part of a die is to be drilled out with, say, a ¼-inch drill, the drill spacer on the punch is set to ¼ inch and the guide point to ⅛ inch full; then no matter what shape is followed the centers will be ¼ inch apart, and ⅛ inch from the line, or a distance equal to the radii of the holes to be drilled. This punch, which is 3½ inches long, is made of 5/16-inch drill rod. The end is drilled and tapped for a threaded center point made from No. 12 drill rod. Care should be taken to see that the threaded end bears against the bottom of the hole so that the shock of the hammer blow will come on the end of the pin and not on the threads, as would be the case if the point were not screwed home. The thread that is exposed is flattened on opposite sides so that the point can be tightened or removed with a pair of pliers or a small wrench. Several points can be made at once by threading a piece of drill rod and pointing and cutting off pieces to the required length while holding the rod in a chuck. These points should be hardened all over and drawn to a light straw color. Both the spacing and the guide points are made of No. 42 drill rod; they are hardened in oil and given a spring temper. These points slide through the body and are adjusted to any length desired. They are held in place by a small screw which is tapped through half of the punch body. The bow or crook in the wires is to give them sufficient spring to adjust themselves. This is a laying-out tool, and is not intended for heavy work. For large drilling, it should be followed by a heavy punch to deepen the marks. WILLIAM A. PAINTER.



Prick-punch with Spacing and Guide Points

Pittsburg, Pa.

INSIDE CALIPER WITH INDICATOR ATTACHMENT

An ordinary 6-inch inside caliper that has been changed somewhat in form to adapt it to precision work, is shown in Fig. 1. One of the legs of the caliper was hammered or upset to make it thick enough to be slotted for an indicator arm, and the other side was cut off to the correct length. This indicator or registering arm is 3½ inches long, and it has a travel of one inch at the point. It is 1/32 inch thick, and the graduated blade (shown more clearly in Fig. 2) is of the same thickness. The latter is recessed in the caliper leg and is fastened with two rivets. A travel of 0.025 inch on the caliper end is equivalent to ½ inch travel on the graduated leg, the pivot or axis multiplying twenty times. The working point *A*, Fig. 2, is made of drill rod and is hardened and rounded on the end. The smallest diameter of the point is 0.050 inch and it projects about 0.065 inch when pushed out against its shoulder. Normally this working point is held against its shoulder by a flat spring *B*. In use, the caliper is adjusted until the pointer stands at zero or at the center of the graduation. As shown, the limit of travel is 0.025 inch in either direction which is sufficient for ordinary work. The caliper is set to the required size, for close fits, with a micrometer, and allowance is then made from the indicator. This tool is especially useful when boring, to test the truth or varations of the work or in making an allowance for driving or running fits. The attachment is, so far as I know, original, as I have never seen anything like it in use, or in catalogues. WILLIAM A. PAINTER.

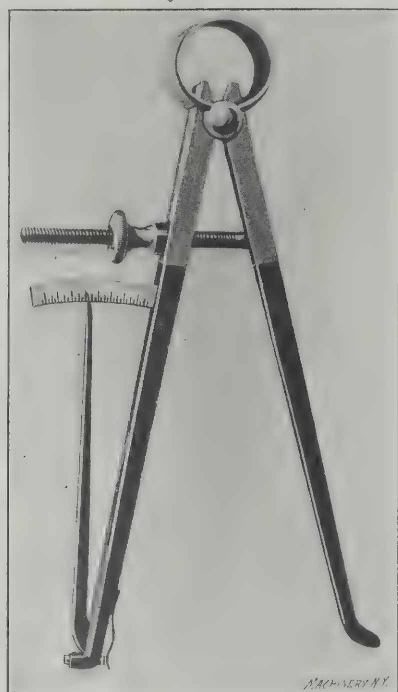


Fig. 1. Inside Caliper with Indicator

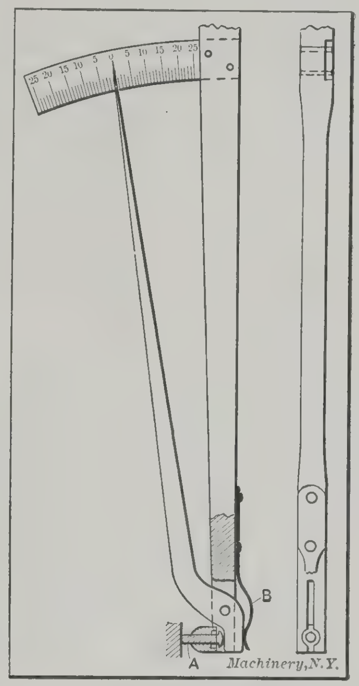
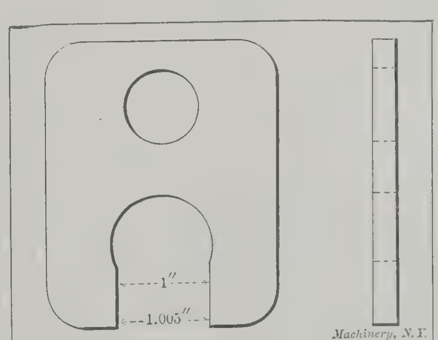


Fig. 2. Detail of the Inside Caliper Indicator Attachment

Pittsburg, Pa.

SNAP-GAGE WITH TAPER TO ALLOW FOR FINISH

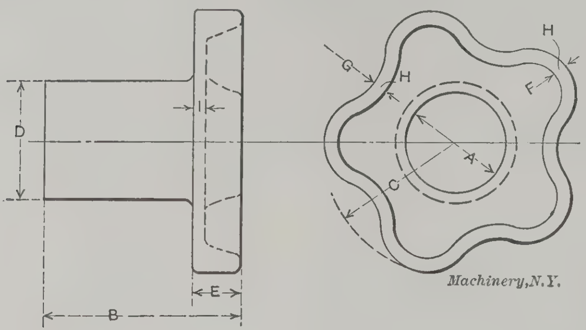
A number of armature shafts had to be finished in the lathe after being first roughed out in a screw machine, and micrometers were being used for measuring them; but there were not as many micrometers available as there were men on the job. Ring-gages were also used for the different sizes of shafts, but the men got along much better when using the micrometers, as they had to allow for finishing with emery cloth, and they could make this allowance much easier with micrometers than with the ring-gages. A lot of snap-gages were then made, which helped us a great deal. They were just like a regular snap-gage, except, instead of grinding the jaws straight all the way, they were ground straight and then re-ground 0.005 inch taper on one side, as indicated in the accompanying illustration, back within a short distance of the end. This left a short part of the gage jaw straight and the rest taper. The men using this style of gage soon became accustomed to it, and the allowances for filing and polishing were easily made. H. D. S.



Snap Gage with Tapered Jaw to allow for Finish

STAR HAND-WHEELS FOR JIGS

An excellent design of hand-wheel for use on jigs, etc., is shown in the accompanying illustration. The dimensions for five different sizes of these hand-wheels are given in the table beneath the engraving. After five years' experience, I have found that the particular style illustrated is well adapted to



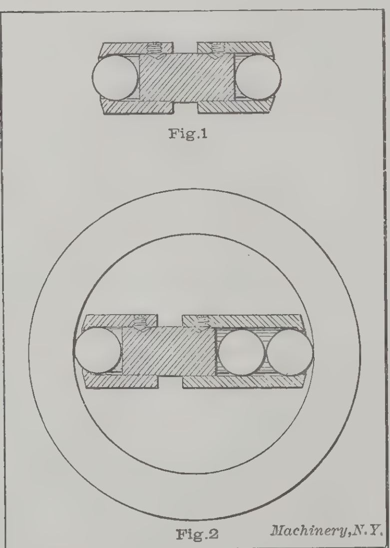
A	B	C	D	E	F	G	H	I
$\frac{3}{4}$	$1\frac{3}{4}$	1	1	$\frac{3}{8}$	$\frac{3}{16}$	$\frac{5}{16}$	$\frac{1}{8}$	$\frac{1}{8}$
1	$1\frac{7}{8}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$\frac{7}{16}$	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{1}{8}$	$\frac{1}{8}$
$1\frac{1}{8}$	2	$1\frac{1}{2}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{9}{16}$	$\frac{3}{16}$	$\frac{3}{16}$
$1\frac{1}{2}$	$2\frac{1}{8}$	2	$1\frac{5}{8}$	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{11}{16}$	$\frac{3}{16}$	$\frac{3}{16}$
$1\frac{5}{8}$	$2\frac{1}{4}$	$2\frac{1}{2}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{16}$	$\frac{1}{4}$

all-around jig use. By having the castings solid, they may be tapped out for any size thread and used in place of nuts, or a plain hole may be drilled and the castings pinned to round stock. The long stem gives a good length of thread for wear and brings the hand-hold far enough from the jig to prevent the fingers and knuckles from striking it. The star design gives a good grip for the fingers, and, as the top is hollowed out, the palm of the hand forms a suction, thus giving a stronger hold. This type of wheel is also easy on the operator's hands, and it is cheaper to produce in quantities, and more powerful than knurled nuts, pins, thumb-screws, etc. This wheel adds to the appearance of a jig and it can be operated very fast.

JIG AND TOOL DESIGNER.

AN INEXPENSIVE SET OF GAGES

As our manager could not be persuaded that a set of gages would be a profitable investment, I decided to make a set; but this did not appear, at first, like an easy job, as there was only a pair of one-inch micrometers to measure with. However, a highly satisfactory set of inside and outside gages, varying by ½ inch, was made. The inside gages have hardened ends, which may be replaced at any time at a cost of only a few cents.



Figs. 1 and 2. Inside Gages made by using Bicycle Balls at the Ends

Cast iron rings for the outside gages were first roughed out to within 1/32 inch of their finished size. To make a two-inch inside gage, a piece of half-inch round, cold rolled steel was first accurately finished to a length of exactly one inch. Two half-inch bushings, ¾ inch long, were then turned on the screw machine and reamed part way through, a shoulder being left at one end to retain the half-inch balls which were placed in the bushings, as shown in Fig. 1.

Bicycle balls were used, and when tested they were found to be within 0.0001 inch of being accurate; therefore I was satisfied that the 2-inch gage was all right. In order to make sure that the balls came up tight against the end of the rod, set-screws were put in the bushings and the rods spotted so that the point of the screw would draw the bushing and with it the ball back against the rod. When this inside gage was finished the outside gage was bored to fit it. To make the 2½-inch gage, one of the bushings from the 2-inch size was removed, and replaced with one a half inch longer, as shown in Fig. 2. In this longer bushing, two balls were placed, thus making it 2½ inches in length. It was then used for turning the 2½-inch outside gage. The one-ball bushing was then replaced and a drop of solder put on the set-screw to prevent its being tampered with. The 2½-inch outside gage was next used as a master, and a rod was dressed down until with one ball at each end it fitted the 2½-inch gage. This process was continued until a number of gages of different sizes had been made.

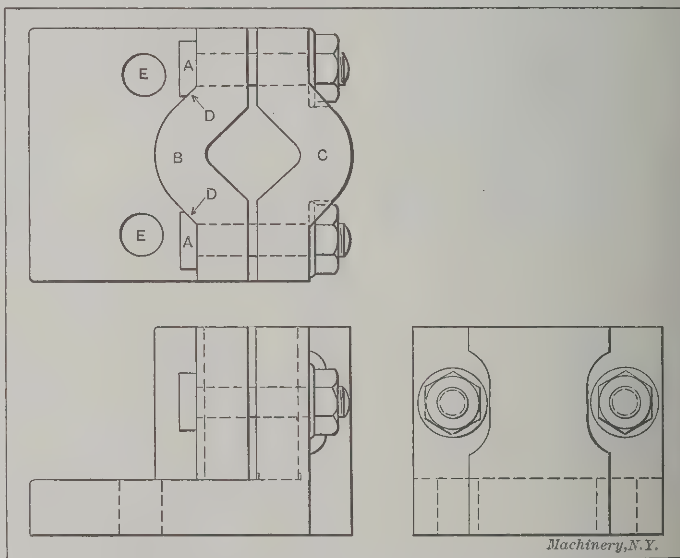
S. A. McDONALD.

Candiac, Canada.

[If gages produced by the foregoing method are to be accurate, it will, of course, be necessary to have a good fit between the ball retaining sleeves and the central plug, and also between the balls and the sleeves, so that the tightening of the set-screws will not cause the centers of the balls to be moved out of line.—EDITOR.]

FIXTURE FOR PUNCH-HOLDERS

A fixture designed for holding punch-holders on the face-plate, surface grinder, or miller, is illustrated herewith. In most shops the die-maker is compelled to use a substitute makeshift affair, which is merely a solid hub and flange with a hole bored and a set-screw in the side. The objectionable



Fixture for Holding Punch-holders of Various Sizes without marring them

features of this "job-spoiler" are legion, the worst one perhaps being the abominable set-screw (or rather the point of it) which, when tightened, not only throws the work over on an angle, but, when set up hard (as is necessary when taking heavy cuts on the miller), leaves unsightly marks in the soft shank.

The design submitted not only eliminates this annoyance, but it is preferable in every way. Obviously, it will take shanks a trifle over or under size as well as all standard sizes in use, the advantage of which should be apparent to any one caring to utilize the space that a half dozen or more of the other kind take up. As the illustration shows, the design of the fixture is very simple. The bolts *A* are a drive fit in casting *B* and a sliding fit in casting *C*. These bolts should have the under edge of the head cut away on one side, as shown at *D*, so they will lock against the side of the casting and not turn when the nuts are set up. The fixture is fastened down in the usual way by T-bolts, holes *E* being for that purpose. If the fixture is to be used for very large shanks, these holes should be placed far enough back so as to allow room for sliding jaw *B*. When so made, the fixture is excellent for grinding sub-press tools, the plunger being removed and held in the same manner as the punch shank. This fix-

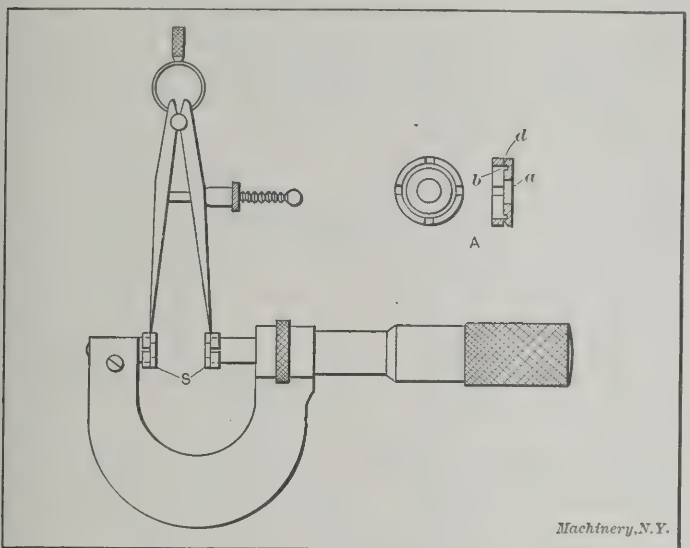
ture also makes an excellent inside angle-plate, it only being necessary to remove the sliding jaw.

The more common way, perhaps, of making tools of this class is to have the projecting base turn the other way; but the advantage in having the foot turn in under the work, as shown, is that when used on a faceplate, it does not overhang so much, thus doing away with much counterbalancing and allowing a smaller faceplate to be used.

Frankford, Pa. ROY PLAISTED.

MICROMETER ATTACHMENTS FOR SETTING DIVIDERS

One is sometimes confronted with the task of setting the dividers or trammels accurately when laying out work, such as jigs, dies, etc. If a vernier with facilities for setting the dividers is not available, the attachments shown applied to a



The Way the Micrometer Attachments are used for Setting Dividers

micrometer in the accompanying engraving will be found very useful, as the dividers can be set with them quite as accurately as when the vernier is used. This is, of course, assuming that the attachments are made accurately.

As the illustration shows, these attachments consist of two sleeves *S*, one of which is fitted to the anvil of the micrometer and the other to the end of the spindle. An enlarged view of one of these sleeves is shown at *A*. A central hole *a* is drilled in the center of the sleeve so that it will be easy to see whether or not it is in contact with the anvil or spindle. Either four or six slots are sawed in the flange to insure a snug fit, and the corner is cut away, as at *b*, so that the inner surface will have a good bearing against the spindle or anvil. A groove *d* is cut in the outside, exactly in line with the inner surface, and into this groove the divider points are inserted when they are being set.

These sleeves are made in the following manner: A piece of tool steel about 1/16 inch larger in diameter than the anvil or spindle of the micrometer, is caught in the chuck and turned true on the outside, after which a central hole is drilled deep enough for the two sleeves. The end of the piece is then bored to a snug fit for the micrometer anvil or spindle, and a recess *b* is turned as shown in the sectional view at *A*. The first sleeve is then cut off, after which the second one is machined in the same way. The cutting of the V-groove *d* is the next and the most important operation. In order to cut this groove exactly in line with the inner surface of the sleeve, a piece is first turned to the same diameter as the anvil or spindle. After the end of this piece is faced square, the lathe carriage and turning tool are left undisturbed. The sleeve is then inserted over the end of the turned rod. By the use of a flat center in the tailstock, this sleeve is held firmly against the squared end of the rod while the V-groove is turned, with the tool set just as it was after the finishing cut was taken over the end of the rod. A depth of about 0.005 inch is sufficient for this groove. Slots are next cut in the sleeves in four or six places so that they may be sprung into place. The sleeves are then hardened and drawn to a blue color.

When turning the groove, and also when turning and facing the rod on which the sleeve is held, care should be taken to see that there is no lateral motion in the spindle of the lathe, as otherwise the tailstock center, when it is brought up against the work, will cause the groove to be out of alignment with the surface on the inside of the sleeve. L. E. KRAMER.

Newark, N. J.

SOLDERS FOR VARIOUS METALS

Soldering is divided into two classes, namely, hard and soft soldering. Ordinarily soldering with a heated copper bit employs "soft solders"—alloys of tin, lead, etc., which melt at comparatively low heats. The use of the blowpipe makes possible the employment of "hard solders" which are alloys of silver, copper, zinc, etc., and melt at a very much higher temperature than the soft solders. The hard soldering of copper, iron, etc., is generally known as brazing, and the solder as spelter. It must be borne in mind that both soft and hard solders deteriorate with age, if kept for a long time in a damp atmosphere. For electrical work, ingredients

SOFT AND HARD SOLDERS FOR VARIOUS METALS

Metal to be Soldered	Flux	Soft Solder		
		Tin	Lead	Other Constituents
Aluminum	Stearin	70	....	Z*25 A* 3 P* 2
Brass	Chloride of zinc,	66	34	....
Gunmetal	rosin, or chloride	63	37	....
Copper	of ammonia	60	40	....
Lead	Tallow or rosin	33	67	....
Block tin	Chloride of zinc	99	1	....
Tinned steel	Chlor. of zinc or rosin	64	36	....
Galvanized steel	Hydrochloric acid	58	42	....
Zinc	Hydrochloric acid	55	45	....
Pewter	Gallipoli oil	25	25	B*50
Iron and steel	Chloride of ammonia	50	50	....
Gold	Chloride of zinc	67	33	....
Silver	Chloride of zinc	67	33	....
Bismuth	Chloride of zinc	33	33	B 34

* Z = zinc A = aluminum P = phosphor tin B = bismuth

Metal to be Soldered	Flux	Hard Solder			
		Copper	Zinc	Silver	Gold
Brass, soft	Borax	22	78	......	......
Brass, hard	Borax	45	55	......	......
Copper	Borax	50	50	......	......
Gold	Borax	22	......	11	67
Silver	Borax	20	10	70	......
Cast iron	Cuprous oxide	55	45	......	......
Iron and steel	Borax	64	36	......	......

such as mixtures of vaseline, rosin, glycerine and chloride of zinc are used as non-corrosive fluxes. The accompanying table gives the composition of both soft and hard solders that are suitable for various metals. A. EYLES.

Manchester, Eng.

MACHINE CATALOGUE COVERS

A common fault with machine catalogues is that while they state just how many accessories are provided, and that this part and that are casehardened, and the other is bronze-bushed, etc., they omit to say how the machines operate and how much work of a given kind they will turn out per hour. Further, some of them do not bear on the cover the maker's name, or even that of the machine described.

How shall I index a catalogue "The Truth about Thingummies" or "The People's Verdict?" ROBERT GRIMSHAW.

Dresden, Germany.

* * *

Manufacturers interested in the International Exposition to be held at Turin, Italy, in 1911 can obtain further information relating to the exposition from the Italian Chamber of Commerce of New York, which has been appointed as the local committee for the United States.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

TINNING STEEL PANS

G. S.—I have about 1,000 steel pans 12 inches long, 8 inches wide, 2 inches high, 1/64 inch thick, to tin. What is the easiest and cheapest method of obtaining a heavy tin coating? The pans are unpolished.

A.—The question is referred to our readers for answer. It is desired that the responses refer to methods of tinning that are practicable to follow in a plant not equipped with tin dipping facilities.

PROPORTIONS OF AUTOMOBILE PISTON RINGS

H. B.—What are the proper proportions of automobile cylinder piston rings? How do they compare with the proportions of gas-engine rings used by the leading gas-engine builders? How much smaller than the bore should a gas-engine piston be turned to secure the best results? We have found that the accepted proportions for steam engine cylinder rings make rings too stiff for gas-engine use.

A.—These questions are submitted to the readers for discussion.

FINISH ON IRON CASTINGS

E. S. S.—1. I have a few castings that I wish to paint and secure a glossy enamel finish. What is the best method to obtain this finish? Could it be done without baking on? I want a finish that will not crack and lose its gloss in a few weeks. 2. Why do gray or streaked spots work through the oxidized finish on malleable iron castings? Is there any way to prevent it? The spots do not show on steel. Is it the fault of poor oxidizing?

A.—These questions are referred to our readers for answer.

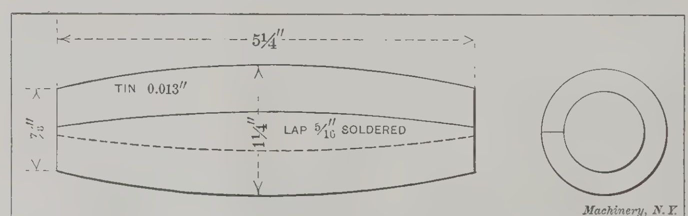
HOW TO BEND TAPERED BRASS TUBES

E. P. D.—I would like to know the best method of bending tapered tubes for automobile horns. The tubes are 9 inches long, 1⅛ inch and ¾ inch diameter at the large and small ends, respectively. The tubes must be bent U-shape, the radius of the inside curve being 1½ inch. The metal is brass, 0.025 inch thick.

A.—Thin brass tubes may be bent without crushing or wrinkling by first filling them with melted rosin or melted sulphur. The bending should be done over a hardwood former shaped to the arc of the curve desired, but as a commercial process for bending tubes in large quantities this method is too slow. Descriptions of improved methods of bending tapered brass tubes are invited from our readers.

HOW ARE COFFIN HANDLES MADE?

R. S. B.—How is the coffin handle shown in the sketch made? It is of tin 0.013 inch thick, with seam lapped about



5/16, and soldered. The work shows very slight evidence of wrinkling, and if made in the press is a very good job.

A.—The question is submitted to the readers of MACHINERY for reply. A contribution describing the tools used for making this or similar pieces will be acceptable.

TO OBTAIN THE HEIGHT OF A SEGMENT WHEN THE AREA IS GIVEN

J. W. H.—How is the height of a segment found that contains one-third the area of a circle 4 inches diameter?

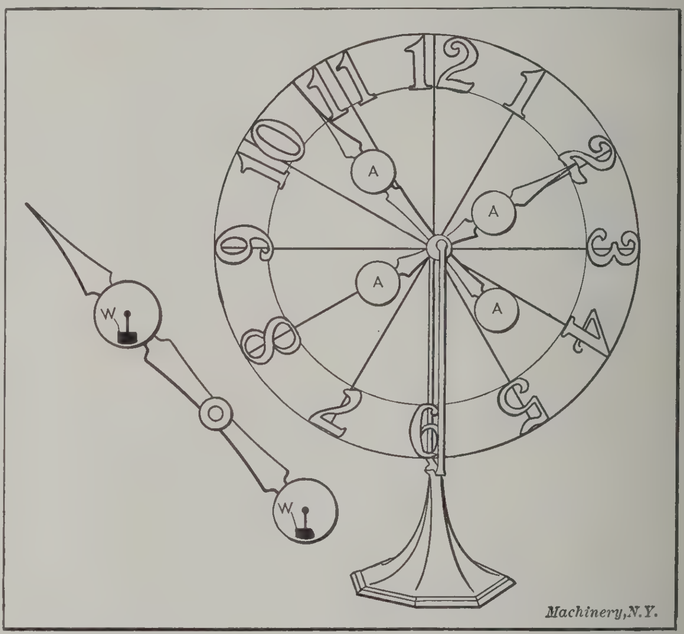
A.—Although the calculation of the area of a segment is comparatively simple, using the approximate formula

$$A = \frac{4\,h^2}{3}\sqrt{\frac{D}{h} - 0.608}$$

the converse proposition is more difficult, as there is no simple formula for finding the height or the chord of a segment when the area and diameter of the circle are given. Recourse must be made to tables of segment areas found in engineers' hand-books. The procedure in this case is as follows: First find the area of a segment that contains one-third the area of a circle having a diameter 1 inch. $1^2 \times 0.7854 = 0.7854$ square inch; $0.7854 \times 1/3 = 0.2618$ square inch, area of segment. Reference to a table of segments shows the height of the middle ordinate to be 0.3675 inch. The height of the corresponding segment of a circle 4 inches diameter is $0.3675 \times 44 = 1.5000$ inch, the required result. This is one of the several problems involving areas of segments, lengths of elliptic arcs, areas of zones, etc., that can be solved by ordinary mathematical processes only by reference to tables.

A CLOCK WITHOUT WORKS?

O. A. A.—What appears to be a most wonderful clock has recently come under my observation, and I would like to have the principle of its action explained. This clock is apparently without works, but it records the time accurately, and when the hands, which are easily moved in either direction, are



spun on their axes, they always come back to the correct position. The dial may also be whirled around, but even though the hands and the dial be set in motion simultaneously, they always come back to their correct relative positions.

A.—This clock is an interesting mechanism, but we believe that it is comparatively simple in its construction. The idea has been used for years in the construction of jewelers' clocks and other clocks where it is desired to attract attention. Usually the hands are made with large hubs in which the clock movements are located, and the hands are driven by the reaction of these movements against a counterweight within the hub. In the case of the clock referred to by our correspondent (see accompanying illustration), there are probably two movements for each hand, which are located in the cylindrical parts *A* and cause the rotation of the hand by reacting against counterweights. These counterweights *W* hang with their centers of gravity below the center of the clock mechanism, and as the hands are perfectly balanced, the action of the works is transmitted through the reaction of the counterweight to the hands, causing them to assume the hour and minute positions. Probably the action of the hands will be more easily understood if we assume that the weights *W* are being continually swung from their vertical position, to the right, thus shifting the hand's center of gravity and causing it to revolve. The two movements in each hand run in unison, the set for the hour hand being geared to revolve once in twelve hours while the minute hand revolves once in an hour. As this construction makes connection with the fixed support unnecessary, the hands, when spun around on their axes, will always come back to the correct position which is determined by the relative positions of the counterweights to the hands in which they are suspended. The dial is easily

made to finally stop in the correct position after it has been spun around, by adding a little additional weight to the bottom, thus throwing it out of balance.

MUTILATION OF U. S. COINS

W. H.—In the December, 1906, number of MACHINERY W. L. McL. described the making of a pretty stick-pin by filing out the profile of the head on a dime. I would like to know if the law regarding the mutilation of coins would apply to this case. If I make a pin in this way am I liable to prosecution?

A.—Technically the making of a stick-pin from a United States coin in the manner described is a violation of section 5459 of the revised statutes. Any defacement or mutilation of gold and silver coins short of complete destruction of the coin or change in shape which will make it impossible for it to circulate as money is, in the opinion of the chief law officer of the treasury department, illegal. It is not likely that an individual who merely makes an ornament for himself or a friend in the manner described would be prosecuted, especially if it were gold-plated afterwards, but anyone *manufacturing* ornaments from mutilated coins probably would get into serious trouble. The chief of the Secret Service informs us that jewelers who make a practice of transforming gold and silver coins into articles of jewelry usually fit a band of like metal around the coin and make any necessary attachments to that band rather than to the coin itself. In this way the coin is preserved in perfect condition, and there is not even a technical violation of the statute.

TO OBTAIN AN ANGLE BY COMBINING THE FEEDS OF A BORING MILL

H. N. K.—To what angle must I set a boring mill head to turn a taper at an angle of 45 degrees with the base when using both feeds in combination. The cross-feed screw is four threads per inch or ¼ inch feed for one turn of the handle, and the down feed is 3/16 inch for one turn of the handle. The pinions on the feed shafts have the same number of

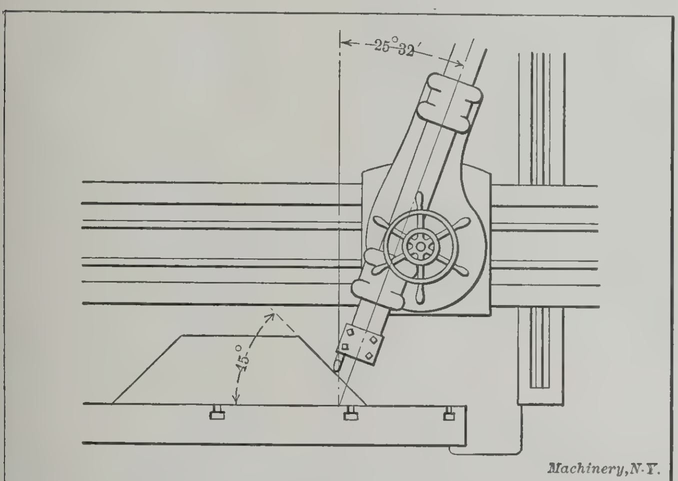


Fig. 1

teeth, and the ratio of feeds, therefore, is as 3/16 to 1/4. I would like to know if there is a method, table or formula for obtaining any desired angle with combined feeds.

A.—The angle can be found graphically in the following construction Fig. 2: Draw the horizontal line AB to represent the boring mill table and the line CD at an angle of 45 degrees, representing the angle to be produced. Now we require to strike two arcs with radii in the proportion of 3/16 to 1/4. To secure the desired accuracy, it is desirable to use longer radii, and we multiply 3/16 and 1/4 by, say, 32, giving as results 6 and 8 inches. With the dividers set at 8 inches, strike an arc from D as a center intersecting AB at E. With E as a center and with a radius of 6 inches, strike another arc intersecting CD at F. Then FEG, the angle made with the vertical EG, is the required angle to which the head should be set. The angle measured with a protractor is 25½ degrees. The method of solving when DEF is less than 90 degrees is:

$$\sin EFD = \frac{H_f \times \sin EDF}{V_f}$$

$$\text{Angle } FEG = (EFD + EDF) - 90$$

in which

H_f = horizontal feed,
V_f = vertical feed,
EDF = angle required on work,
FEG = angle to which the head must be set to produce angle EDF,

$$\sin EFD = \frac{1/4 \times 0.7071}{3/16} = 0.9428.$$

The angle whose sine is 0.9428 is found in a table of sines to be 70 degrees 32 minutes. Angle EDF = 45 degrees. Then

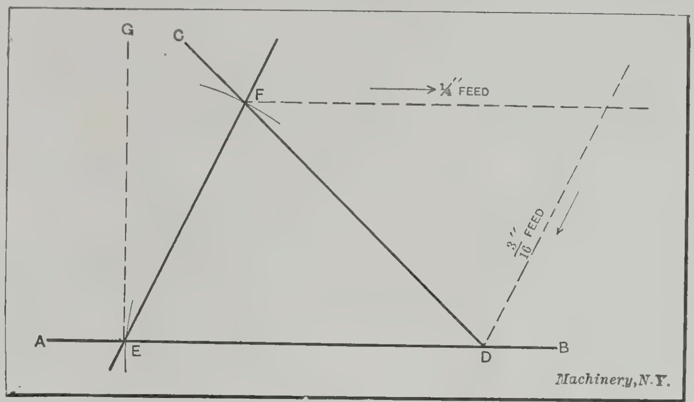


Fig. 2

angle GEF = (70 degrees 32 minutes + 45 degrees) — 90 degrees = 25 degrees 32 minutes. The same methods may be used for finding the angles produced by combined vertical and horizontal planer feeds.

* * *

FORMULAS FOR CALCULATING A FRICTION DISK BRAKE*

JOHN WILL†

In the following article will be given a set of formulas for calculations relating to the well-known mechanical brake used on electric hoists. A diagrammatical sketch of such a brake is shown in Fig. 1. An example illustrating the use of the formulas given will also be worked out.

The object of the brake shown is to permit the lowering of the load at a constant speed with the power reversed, and the holding of the load suspended when the current in the motor is shut off. When the load is lowered it rotates, by means of the drum and gearing, the flange D against the ratchet disk H; the flange D is mounted as a nut on the screw A; the flange C is keyed to the shaft as shown. The pawl engaging with the ratchet disk does not permit it to rotate when the load is lowered. As the ratchet disk thus is stationary, the work of the motor and of the lowered load must equal the work absorbed by the friction surfaces in the brake. When hoisting, the motor rotates the flange D against the nut E so that then there is no pressure on the friction disks; the motor is thus free to hoist the load without any frictional resistance.

The amount of opening between the friction disks should be as small as possible, and the number of teeth in the ratchet disk as great as possible, consistent with required strength. In this way excessive pressure on the ratchet teeth, due to the sudden dropping of the load when the current in the motor is shut off after hoisting, may be avoided. The drop of the load, of course, is proportional to the opening between the friction disks, and the amount the pawl allows the ratchet disk to rotate before engaging a tooth and stopping it positively.

The action of the load and the motor on the brake may be explained by a simple illustration. In Fig. 2 the bar A is shown resting on two wedges B between the walls C. The load P is a constant pressure acting downward on the bar A. This pressure, however, is not great enough to overcome the frictional resistance between the wedges B and the walls C. If an additional downward pressure P_1 is put on the wedges, so that the combined pressures P and P_1 equal or exceed the frictional resistance, then the bar and the wedges will slide

* Answer to an inquiry in the How and Why department, January, 1905.
† Address: 180 South 11th St., Newark, N. J.

downward as a whole. In the mechanical brake in Fig. 1 the load on the hook may be considered as the pressure P in Fig. 2. The pressure P_1 may be assumed to be the effort exerted by the motor in order to lower the load.

In the formulas following, the notation below will be used:

E = energy absorbed by friction disks in foot-pounds per minute,
E_1 = energy of the lowered load in foot-pounds,
E_2 = energy of the motor in foot-pounds,
e_1 = total efficiency of mechanism between load and flange D, Fig. 1,
e_2 = total efficiency of the mechanism between the motor and flange C, Fig. 1.
T = torque in inch-pounds on pinion F,
r = mean radius of screw in inches,
r_1 = inside radius of friction disks in inches,
r_2 = outside radius of friction disks in inches,
n = number of friction surfaces,
N = number of revolutions per minute of flanges C and D,
A = area of each friction disk in square inches,
W = total pressure in pounds on friction disk,
f = coefficient of friction between the flanges and the friction disks,
P = lead of the screw in inches,
ϕ = angle of repose of screw in degrees,
α = helix angle of the thread of screw in degrees,
y = number of thermal units of heat conducted away per square inch of bearing surface per minute; y may be considered to be from 4 to 7, when the mechanism is exposed to a current of cold air and in intermittent service, and as equal to 0.75 to 1 in tolerably cool places with intermittent service.

When a sufficient number of quantities are known, energy absorbed by friction, the pressure on the disks and the lead P of the screw in the brake may be found by the following formulas:

$$E = E_1 e_1 + E_2 e_2 \qquad (1)$$

$$E = 0.349\, n f W N \frac{r_2^3 - r_1^3}{r_2^2 - r_1^2} \qquad (2)$$

$$W = \frac{T}{r \tan(\alpha + \phi)} \qquad (3)$$

$$P = 2 \pi r \tan \alpha \qquad (4)$$

$$y = \frac{E}{778 \times 2A} \qquad (5)$$

[Formula (2) is based on the theoretical assumption that the mean radius at the end of which the resultant of the frictional forces may be considered as applied, equals

$$\frac{2}{3} \times \frac{r_2^3 - r_1^3}{r_2^2 - r_1^2}$$

thus taking the radius to the center of gravity of the small trapezoids into which the annular ring may be supposed to be divided. Although this is correct both theoretically and practically when the brake is new and the pressure distributed uniformly over the entire surface, the disk wears faster on the outside edges than on the inside, resulting ultimately in greater pressures at the inner edge, and it has been found that a formula considering the mean radius as the arithmetical mean between the outside and inside radii gives better results for working conditions.—EDITOR.]

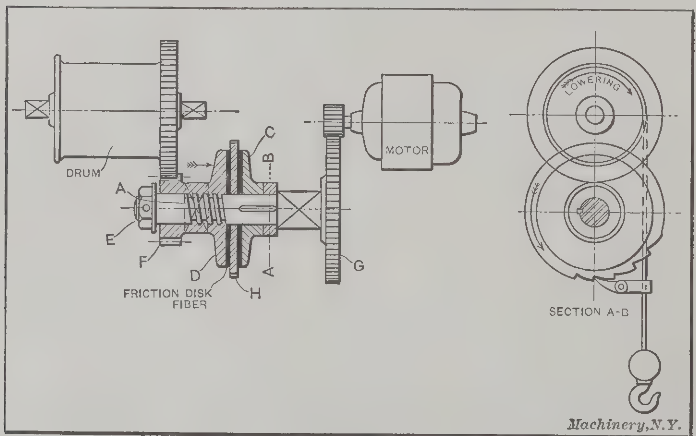


Fig. 1

Example:—Assume that we have the following data: At 230 volts and a speed of 1,000 revolutions per minute, 25 amperes are required for hoisting the load. At a speed of 1,500 revolutions per minute, 9 amperes are required for lowering the load. The motor efficiency is 80 per cent, the drum is 12 inches in diameter, the drum gear ratio is 1 to 7, and the motor gear ratio is 6 to 1. The efficiency of each set of gearing is 90 per cent. The outside radius of the friction disks is 7 inches, the inside radius 3 inches, and the mean radius of the screw, 1¼ inch. The number of friction disks is 2, as shown in Fig. 1, the number of revolutions of the friction disks is $1{,}500 \div 6 = 250$, the coefficient of friction between the flanges and the friction disks is 0.07, and the angle of repose of the screw, 8 degrees 30 minutes. From this data we find that the maximum load of 2,200 pounds may be hoisted at a speed of 75 feet per minute and lowered at a speed of 112.5 feet per minute, as follows:

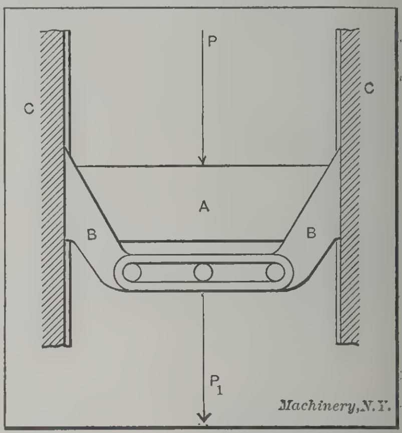


Fig. 2

$$\frac{1{,}000 \times 12 \times 3.14}{6 \times 7 \times 12} = 75 \text{ (hoisting speed)},$$

$$75 \times 1.5 = 112.5 \text{ (lowering speed)},$$

$$\frac{230 \times 25 \times 44.2 \times 80 \times 90 \times 90}{75 \times 100 \times 100 \times 100} = 2{,}200 \text{ pounds, nearly.}$$

We will now find the lead P of a screw which will give a lowering speed of 112.5 feet per minute with the given conditions.

$E_1 e_1 = 2{,}200 \times 0.90 \times 112.5 = 222{,}750$ foot-pounds.

$E_2 e_2 = 230 \times 9 \times 44.2 \times 0.90 \times 0.80 = 65{,}900$ foot-pounds.

From formula (1):

$E = E_1 e_1 + E_2 e_2 = 222{,}750 + 65{,}900 = 288{,}650$ foot-pounds.

From formula (2):

$$W = \frac{E}{0.349\, n f N \dfrac{r_2^3 - r_1^3}{r_2^2 - r_1^2}} = \frac{288{,}650}{0.349 \times 2 \times 0.07 \times 250 \times 7.9} =$$

3,000, approximately.

From formula (3):

$$\tan(\alpha + \phi) = \frac{T}{W r} = \frac{[(2{,}200 \times 6) \div 7] \times 0.90}{3{,}000 \times 1.25} = 0.453.$$

Hence, $\alpha + \phi = 24° \, 20'$, and $\alpha = 24° \, 20' - 8° \, 30' = 15° \, 50'$.

From formula (4):

$P = 2 \times 3.14 \times 1.25 \times \tan 15° \, 50' = 2.23$ inches.

This gives a screw of practically 2¼-inch lead. If a double thread is used the pitch will be 1⅛ inch.

From formula (5):

$$y = \frac{288{,}650}{778 \times 2 \times 125.6} = 1.48,$$

which would be satisfactory when the brake is well exposed to the air.

The maximum allowable pressure per square inch on the friction disks should be limited to 200 pounds. In the example above we find that the pressure equals

$$\frac{W}{A} = \frac{3{,}000}{125.6} = 24 \text{ pounds per square inch, approximately.}$$

* * *

Don't start a piece of work until you have measured and examined the stock to see if it is correct for size and kind.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

MILWAUKEE PLAIN MILLING MACHINE

In the department of New Machinery and Tools in the August, 1908, issue of MACHINERY was described the No. 3B Milwaukee universal milling machine, made by the Kearney & Trecker Co., of Milwaukee, Wis. The same general lines of design followed in that machine have now been applied by the makers to their plain milling machine, which is here described and illustrated, with the changes permitted by the absence of the swivel carriage for the table. In connection with this plain design of machine, we are able to show a number of details of the very interesting driving and feed mechanism employed.

The main features of this line of machines are the geared feed and speed changes, the provision for continuous lubrication from an oil reservoir, and the permanent arrangements incorporated in the machine for supplying lard oil or other compound to the cutting edges of the mill. In connection with the first point, it will be remembered that the makers of this machine built it with geared drive only, their confidence in this construction being such that they have entirely abandoned the cone pulley, and do not employ it in any size or style of their products.

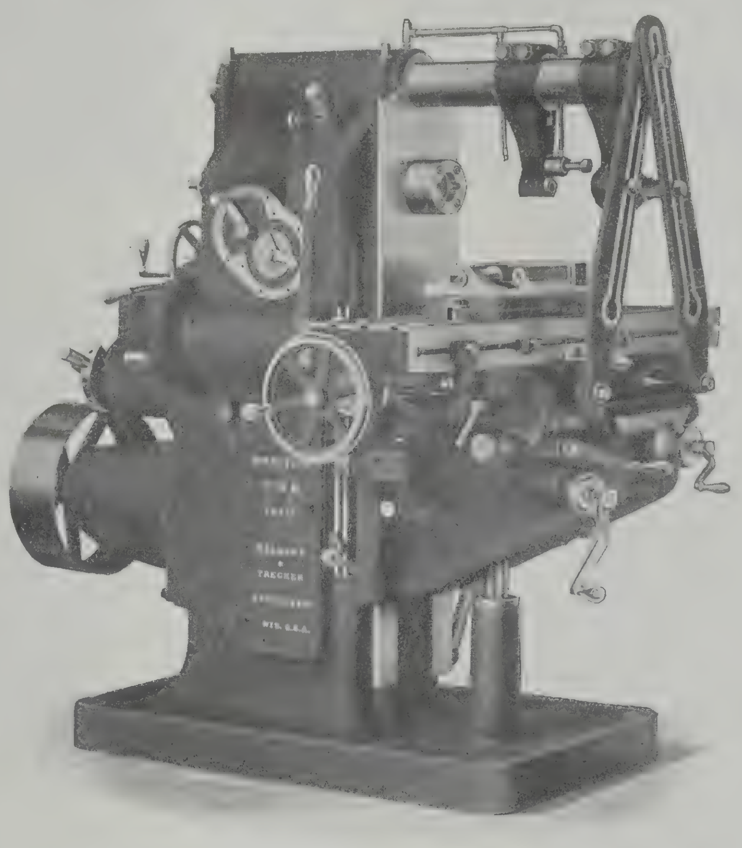


Fig. 1. Milwaukee No. 2B Plain Milling Machine, with Geared Drive and Feed

Structural Features

Rigidity in the framework is a fundamental requirement for an accurate and productive tool. In this machine the column is cast in one piece, with strong internal ribs. It has a box section, with as few and as small openings as possible, and it increases in depth as it extends downward toward the pan-shaped base. This latter is sufficiently high to leave room for heavy ribbing, which makes masonry and cement foundations unnecessary where the floor is strong enough to carry the load. The sliding surfaces for the knee extend clear to the top of the column around the spindle box, thus giving the needed additional metal at this point. The upward extension of the slide serves also as a convenient means of fastening the various attachments, which thus become practically an integral part of the machine, and capable of very severe service.

The knee is of the enclosed box form, with as few openings as possible, none being permitted in the upper surface. This is important as it obviates all danger of the closing together of the surfaces under the strain of clamping the saddle. It also obviates the necessity of a sliding cover to keep chips out of the knee mechanism. A long bearing is provided for the knee on the column, extending up above the saddle bearing.

The over-arm is a solid steel bar, located with great accuracy parallel to the spindle. The arbor supports are firmly clamped to this. The arm braces have been especially designed with regard to convenience in handling, there being no single piece too heavy for one man to adjust with ease. Throughout the structural design metal has been added with the single purpose of securing strength and ridigity; it has not been placed here and there in a haphazard way, merely for the purpose of getting a high total weight for selling purposes.

Spindle Driving Mechanism

The arrangement of the drive is best shown in the vertical section through the column, Fig. 2, in connection with the small details in Figs. 3 and 5. The driving pulley *A* runs at constant speed in one direction, there being no necessity for cone pulleys or a reverse clutch in the countershaft. The shaft on which it is mounted carries an integral pinion meshing with gear *B*, which is loose on the shaft above it. The hub of this gear carries a steel jaw clutch engaging a similar clutch on the face of gear *C*, which is keyed to the shaft. *B* is shifted longitudinally to engage or disengage the clutch connection by means of the vertical hand lever shown on the left side of the column in Fig. 1. Gear *C* meshes with *D*, which, in turn, may be connected with constant speed shaft *E*, either directly or through the medium of idler gears *F*. The shifting of pinion *G* by handle *H* governs this connection, and thus reverses the spindle.

In transmitting the motion from shaft *E* to *J*, six changes of speed are provided for by an interesting modification of the tumbler gear type of speed change mechanism. In this case a compound tumbler gear *K* having three steps, is used as shown. This meshes with the keyed sliding gear *L* on shaft *E*, and is carried by the swinging frame *M*. Either one of the three steps of gear *K* can be made to engage with either of gears *N* or *O* on shaft *J*, thus giving the six changes of speed.

The solid support given to the sliding gear *K* should be noted. It revolves on a hardened steel stud, firmly fastened in the steel frame. This latter is securely supported on both sides of the tumbler—on one side by shaft *E* which is, for this purpose, made much larger than would otherwise be required; and on the other side by the teeth of the long pinion *P*. This latter is rocked by handle *Q* to raise or lower the tumblers into proper position to mesh with the gear *N* or *O*. The shifting of the tumbler lengthwise is effected by the lower swinging handle on the front of the frame in Fig. 1, operating through the segmental gear and rack shown at *R* in Fig. 4.

Three additional changes of speed are effected by sliding gear *S*, which may be shifted to the rear so that its small diameter engages with gear *O*, or it may be set in a central position where its larger diameter, as shown in Fig. 2, engages gear *N* on shaft *J*. Moving it still further to the right clutches it, by means of the driving pin shown, to the large gear *T*, which runs loosely on the spindle, driven by a pinion on shaft *J*. Eighteen changes of speed are thus provided for through a mechanism which is strong and direct.

The feed change mechanism is identical in principle with that provided for the spindle changes. Twelve rates of feed are provided for, controlled by convenient levers and indicated by an indexing plate. The feed is driven directly from the shaft on which gear *D* is mounted, so that it is driven at a

constant rate, giving definite feeds in inches per minute. This construction has become standard for efficient milling machine design, since it permits all the feed changes to be practically applicable to any speed, and thus allows a greater number of effective changes for the whole range of speeds, from that required for small mills on soft metals, down to the heaviest work the machine is capable of.

In any geared feed and speed mechanism the efficiency and durability of the gearing, bearings, etc., is largely dependent on the care with which they are lubricated. In this machine a reservoir of machine oil is provided from which a stream is kept constantly flowing whenever the driving pulley is in motion, over all the gears and into all the journals. These journals are provided with oil grooves open at the ends to permit a constant and rapid flow, thus keeping them constantly cool and flushed of foreign matter. This point in the design of these machines is so well known that it is not necessary to expatiate on it further.

For holding the spindle in inserting or removing cutters, etc., or for using fly cutters, a stop is provided which engages

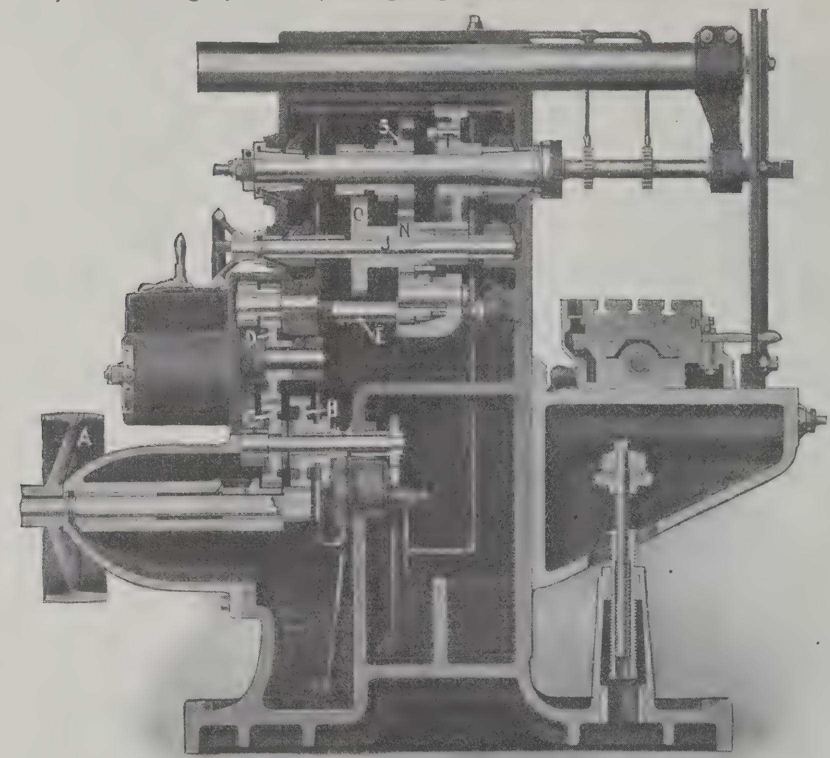


Fig. 2. Section through Column, showing Spindle Drive

the teeth of large gear T. This engagement extends over several of the teeth, which it fits accurately. It thus holds the spindle without play and without danger of breakage. For turning the spindle through small fractions of a revolution, a handwheel is provided at the rear end of shaft J as shown. This makes possible more delicate adjustment than can be obtained even on the belt-driven machine. A knock-out for arbors and taper shank mills is permanently mounted in the machine. Large face mills are driven by a key and keyway set into the front face of the spindle. They are clamped in place by four screws passing through the mill into the spindle flange. This arrangement is preferable to the thread usually provided for the purpose, since this thread, if too fine, permits the cutters to jam in place under the strain of a heavy cut, and makes it difficult to remove them; while, if the lead be made steeper, there is a constant tendency to work loose.

Details of the Feed Control

Another detail of the machine is seen in Fig. 4, which shows a vertical section through the knee, exposing the mechanism by which the table cross and vertical feeds are interlocked with each other so that no two can be engaged simultaneously. The telescopic shaft from the feed box leads to gear U, from which, through the intermediate gearing and clutch shown, the motion is transmitted to gear V. The clutch W serves to reverse the feed for movements in all directions.

Gear V gives movement to any one of three shafts, X, Y and Z. X is for the table feed, Y for the cross-feed and Z for the vertical movement. As shown in the engraving, with lever A_1 in the central position, clutch X is engaged, and consequently the table feed gearing is in motion. Whether the feed is in actual operation or not depends, of course, on whether the feed handle at the front of the table is thrown in. Now in order to have the plunger of lever A_1 enter the hole provided for it in the central position, it must pass through a hole in lever B_1 which must consequently also be in its central position. B_1 controls the clutches at Y and Z, respectively, which thus are always disengaged whenever the clutch at X is thrown in.

Lever B_1 and the clutches with which it is connected are operated by a lever at the front of the saddle, which thus

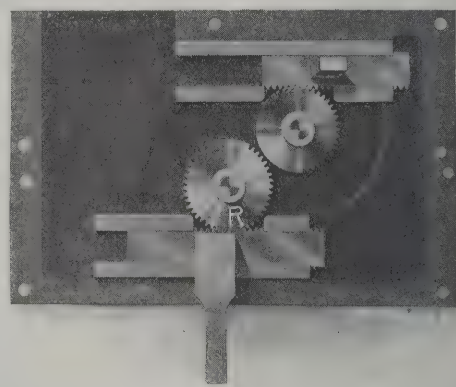


Fig. 3. Spindle Change Gear Controlling Mechanism

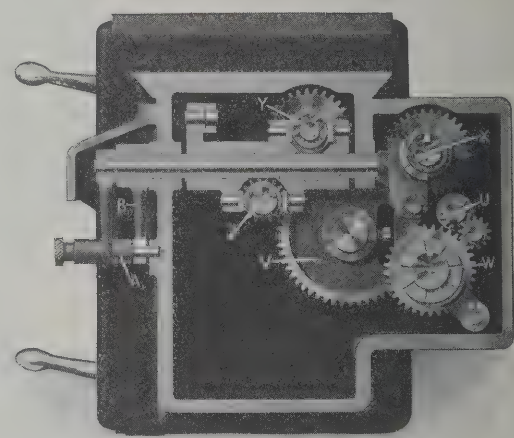


Fig. 4. Interlocking Feed Control in Knee

serves to throw in or out the vertical and cross movements, respectively. Since these movements are locked, as explained, when the table feed is engaged, it is necessary before using either of them to disengage that feed. This is done by throwing lever A_1 to either one side or the other (depending on whether cross or vertical movement is desired) and locking it in this position. Lever B_1 and the clutches with which it is engaged are thus free to swing from the central or off position to one side or the other under the influence of the lever at the front of the saddle. It is thus possible to use this lever for throwing in or out either the vertical or the cross feed, depending on which side of the center lever A_1 is located.

Fig. 2 shows the two sets of oil reservoirs and pumps supplied. The pump in the double front compartment forces a constant supply of cooling fluid over the cutters through piping regularly provided. Chip channels are formed in the table and a jointed pipe drain connection leads the lubricant back into the settling chamber again, so that a constant stream is provided to cool the cutters. This gives better finish, allows heavier cuts, and prolongs the life of the cutting edges of the tools. This useful provision is regularly furnished and does not have to be specially specified.

General Design

It will be seen that these machines are designed with the idea of providing for ample spindle power, for rigidity suffi-

cient to permit the highest output of any cutter that may be used, and for the accuracy required for interchangeable manufacturing. The convenience of the changes also adds highly to the productive capacity. Besides the universal type previously illustrated and the plain machine here described, the builders furnish this tool in a simplified form which they call their manufacturing machine. This retains the same features of feed and speed change and the same general construction throughout, but has a simpler feed mechanism in the knee and saddle, the power feed being applied only to the longitudinal table movement.

The bracket on which the constant speed driving pulley *A* in Fig. 2 is mounted is interchangeable with two other styles, so that any machine may be fitted up as required by the customer. One of these alternative forms gives a right angle constant speed pulley drive, for use where the line shaft and floor arrangements make this style preferable. The third style of bracket provides for the mounting of a constant-speed motor of any standard commercial type. It should preferably be of 5 horsepower, and capable of carrying 50 per cent overload for an hour without danger. The three systems of drive can be interchanged with each other at any time, without special preparation or changes in the machine.

The following dimensions refer to the No. 2B plain milling

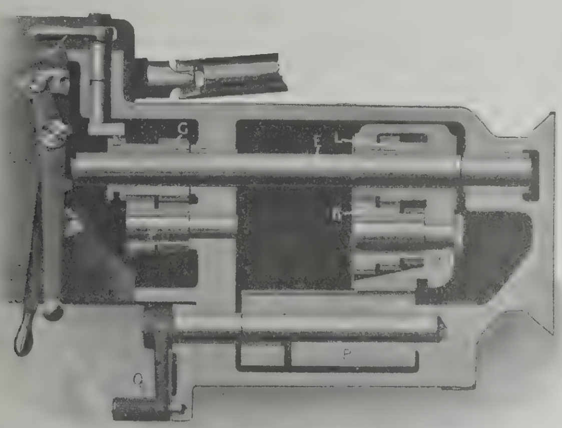


Fig. 5. Design of Tumbler Gearing for Spindle Drive

machine. The driving pulley is 16 inches in diameter for the 4½-inch table belt, and runs at 300 revolutions per minute. The spindle is of forged crucible steel, running in bronze bearings, adjustable for wear; it has a No. 11 Brown & Sharpe taper hole. Eighteen spindle speeds are provided in geometrical progression, ranging from 15 to 360 revolutions per minute with a maximum gearing ratio of 20 to 1. The twelve feeds range from ½ to 60 inches per minute. The table has a working surface of 47 by 12 inches with three T-slots. A plain vise and all necessary wrenches are furnished with the machine. The net weight is about 3,900 pounds.

FUNK MACHINE CO.'S POSITIVE PRESSURE BLOWER

An interesting type of rotary blower has just been brought out by the Funk Machine Co., 23-27 City Hall Place, New York. This firm, which manufactures printing and book-binding machinery, designed this blower for use in connection with a feeding machine. When the blower was tested, it proved so efficient that it was decided to place it on the market. An exterior view of the blower is shown in Fig. 1, while Fig. 2 shows the interior mechanism which consists of only a suction and discharge valve, and a piston with the two impeller blades. The valves which are closely fitted between the outer cylinder and the piston or central drum, are driven from the main shaft by gearing, as indicated in Fig. 1. This gearing is so proportioned that each valve makes two revolutions to one of the main shaft. The valves are crescent shaped in cross-section, and have solid disks on each end. Each valve is so set in relation to the impeller blades that the crescent-shaped part, which extends the width of the cylinder, rolls over the end of each blade as it passes. The impellers may be rotated in either direction, as a change in the direction of their movement simply causes a corresponding change in the position of the suction and discharge outlets.

If we assume that the piston, when viewed from the side shown in Fig. 2, is given a counter clockwise movement, the action of the blower would be as follows: As one blade passes the lower, and what in this case would be the suction opening, the air is drawn in back of it, the valve just above this opening being closed. As this blade moves around toward the top of

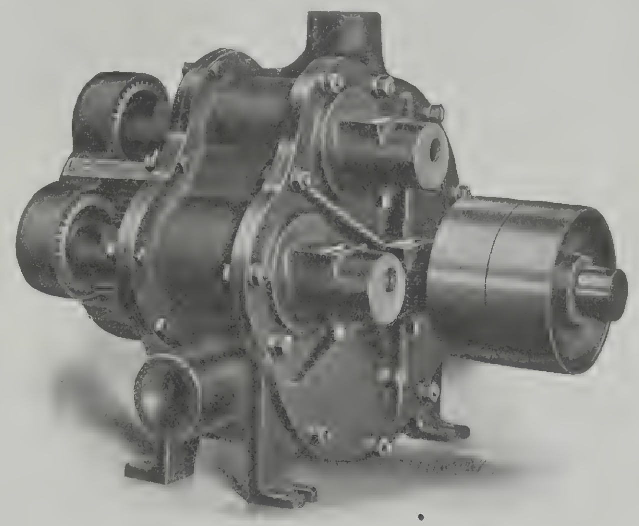


Fig. 1. Rotary Blower built by the Funk Machine Co.

the cylinder, this air is forced out through the discharge port by the following blade, as the space between the piston and cylinder is closed by the upper or discharge valve. When a blade is passing the discharge valve, the suction valve is closed, and remains so until the discharge valve has again moved around sufficiently to seal the space between the cylinder and the central drum or piston.

The impeller blades are of steel, and are firmly attached to the piston. Neither the blades nor the piston bear against the cylinder, but they are made with as little clearance as possible in order to reduce the friction to a minimum. An important point in the construction of this machine is that the friction remains practically constant as the discharge pressure increases. The valves are of bronze, as are also the pinions

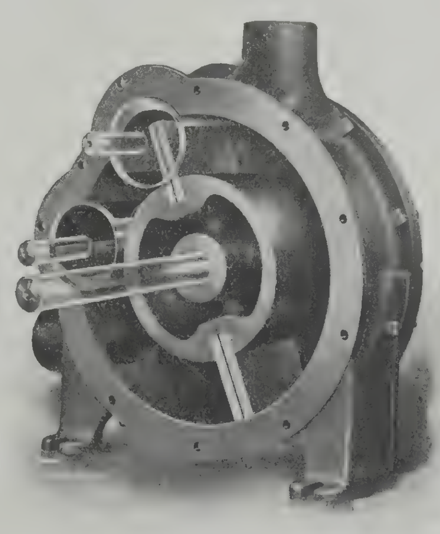


Fig. 2. Interior View of the Rotary Blower

by which they are driven. All bearings are self-oiling, and there are no parts that are likely to become deranged. These machines are built, at present, in three sizes, designated as Nos. 1, 2 and 3. The makers state that during a test run the smallest size delivered 45 cubic feet of air per minute, and maintained a pressure of 2 pounds against five openings ¼ inch in diameter, with a power consumption of 4/10 horsepower. The capacities of the two larger sizes are two and three times that of the smallest size, respectively. Obviously, this blower may be used either for exhausting or compressing air, or for both purposes simultaneously.

NEW LINE OF KELLY CRANK SHAPERS

A new line of crank shapers is now being manufactured by the R. A. Kelly Co., Xenia, O. In designing these shapers, one size of which we illustrate herewith, the company gave special attention to the proper distribution of the metal in order to have a machine with sufficient strength to resist the greatest working strains that are likely to be imposed on it by the use of high-speed steel. The question of strength in this connection, has not alone been considered, as the driving mechanism for each size is so proportioned as to give the greatest output within the limits of high-speed steel tools. This has been accomplished by using wide-faced, accurately-

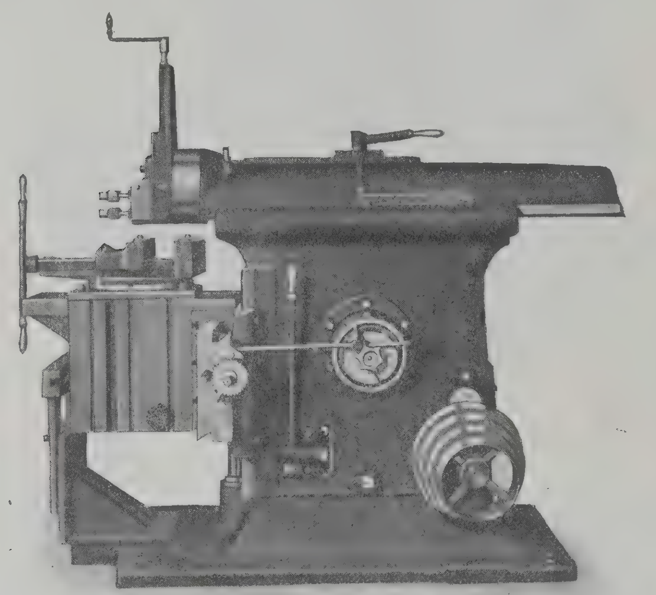


Fig. 1. New Design of Kelly Crank Shaper

cut gears, and employing high gear ratios, ranging from 24 to 1 to 33.2 to 1 in the 16- and 26-inch machines, respectively.

The arrangement of the driving mechanism is illustrated in Fig. 2. The drive is transmitted from a 4-step cone-pulley to the bull-wheel through either of two trains of gears, depending on the speed desired. By shifting the double-ended pinion *A*, which is free to slide on the driving shaft, to either of its extreme positions one of these trains is brought into action. The position of pinion *A* is changed by the vertical lever seen just back of the cross-rail in Fig. 1. It will be seen

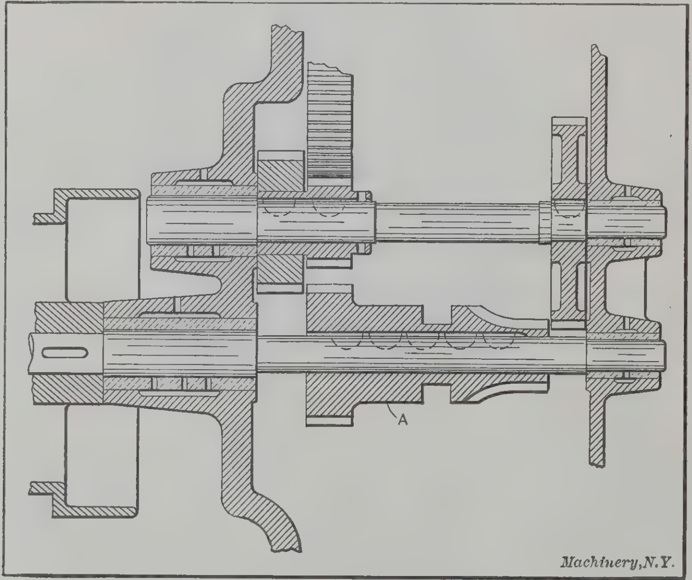


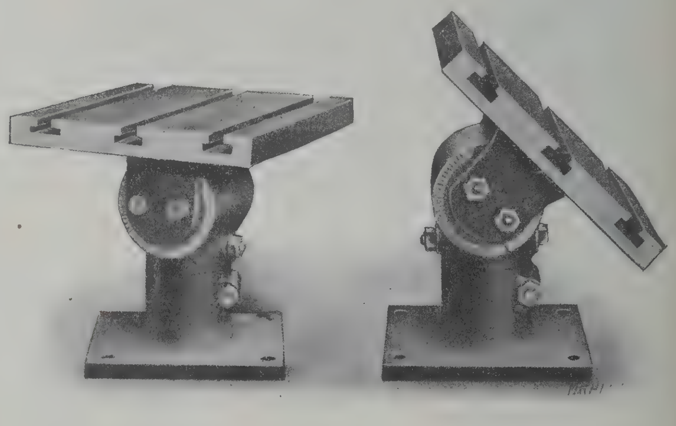
Fig. 2. Detail of the Driving Mechanism

then that the four cutting speeds obtainable from the four steps of the cone-pulley, may be doubled by this arrangement of back gears, giving eight speeds in all. The machine may, of course, be stopped by shifting the driving pinion to its neutral position between the gears with which it meshes.

The bases of these machines are very heavy, and are provided with internal ribs giving them great rigidity. The table, which is of box form, is rigidly supported at its outer end as the engraving indicates. All the bearings in the column are cast integral with it, and those on the larger machines are bored and bushed with Lumen metal. These bearings are of ample length, and all are provided with oil pockets that will hold enough lubricant for one week's steady work. All of the machines have power elevating screws which are so arranged that they can be used as a power down feed on a great deal of work that is ordinarily done on a shaper. Each screw is of the telescoping type, thus making it unnecessary to bore clearance holes in the floor. The stroke of the ram can be changed while the machine is in motion or at rest, and a suitable scale indicates what the stroke is. A study of the machine illustrated, indicates that considerable thought has been given in the design, to the convenience of the operator. This is, of course, an important feature, as the efficiency of a tool of this kind, which is usually employed on a great variety of work, depends largely on the ease and convenience with which various changes, incident to the operation of the machine, can be made. Any of these machines will be arranged for electric drive if desired. The makers are also prepared to furnish any shaper attachments such as index centers, concave attachment, moldmakers' vise, etc., which may be wanted.

WILLIAMSON UNIVERSAL MACHINE TABLE

A new style of universal drill press table or angle-plate is now being made by the Williamson Vise Co., Bradford, Pa. Formerly the shank of this table was clamped to the table-arm of the drill press, the regular table being removed. The new design, which is illustrated herewith, is provided with an in-



Views illustrating the Movements of the Williamson Universal Table

dependent base which makes special changes, incident to its use, unnecessary. This table may be supported either on the regular platen, or on the machine base for large and heavy work. As the engraving indicates, the table may either be rotated in a horizontal plane or swung about its bearing to any desired position from the horizontal to the vertical. The angle for any position is indicated by suitable graduations. These tables are made in six different sizes: The platen of the smallest is six inches square, and its height, when in a horizontal position, is eight inches. The corresponding dimensions of the largest size are 30 and 41 inches, respectively. The usefulness of such a tool in a shop is so obvious that further comment is unnecessary.

SPRINGFIELD 36-INCH MOTOR-DRIVEN LATHE

Among the firms to recognize the superiority of the electric drive for machine tools, may be mentioned the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O. This firm has given particular attention to the design and arrangement of the electrically-driven engine lathes which it manufactures. One of the heavy lathes built by this company, which has recently been equipped with a motor-drive, is illustrated herewith. This machine has a swing of 37 inches over the bed and 24 inches over the carriage. The driving motor is of 7½ horsepower and it has a speed range varying between

600 and 1,200 revolutions per minute. Special attention has been given to the design of the headstock, which is completely enclosed and of symmetrical proportions. This enclosed type of headstock not only lessens the danger of accident, but greatly adds to the massiveness and strength of this part. The driving mechanism is provided with gears having wide faces, and is strongly constructed throughout. There are six mechanical changes of speed, which, together with the changes obtained from the motor, give all the necessary speeds required for a lathe of this size.

A sectional view of the headstock is shown in Fig. 2. The drive from the motor shaft is through a rawhide pinion that is shown directly back of the gear with which it meshes. This driven gear is keyed to a shaft which may properly be called the countershaft. On this countershaft there are three sliding gears which are tied together as one unit. These are brought into engagement with corresponding gears on the lathe spindle by means of the handle shown in the end elevation. By engaging first one and then the other of these gears three variations or mechanical changes of speed are obtained. These three changes are doubled by the use of back gears as in the ordinary lathe. The controller of the motor is mounted on the right side of the carriage, so that while it is convenient for the workman, it is not located so as to interfere with the operation of the lathe. As the illustration shows, this controller is connected through bevel gears to a splined rod extending the length of the bed, which transmits the movement to the starting box. This method of operating the motor from the carriage has proved so satisfactory that all the motor-driven lathes made by this company are so arranged. This lathe is adapted to cut threads ranging from 1/16 inch to 4 inches pitch. The lead-screw is prevented from sagging by a support which travels on the bed with the carriage and automatically stops off at certain points. This insures a longer life to the lead-screw and more accurate work from the machine. The lathe is equipped with power feeds for either longitudinal or cross movements, and, in addition, there is also power feed for angular positions of the compound rest. A dial in front of the headstock is so arranged as to give three changes of feed for screw cutting. There are also two intermediate positions in which the lead-screw remains stationary. This dial, together with a few change-gears, gives all the necessary changes ordinarily required for feeding or screw cutting on a lathe of this size.

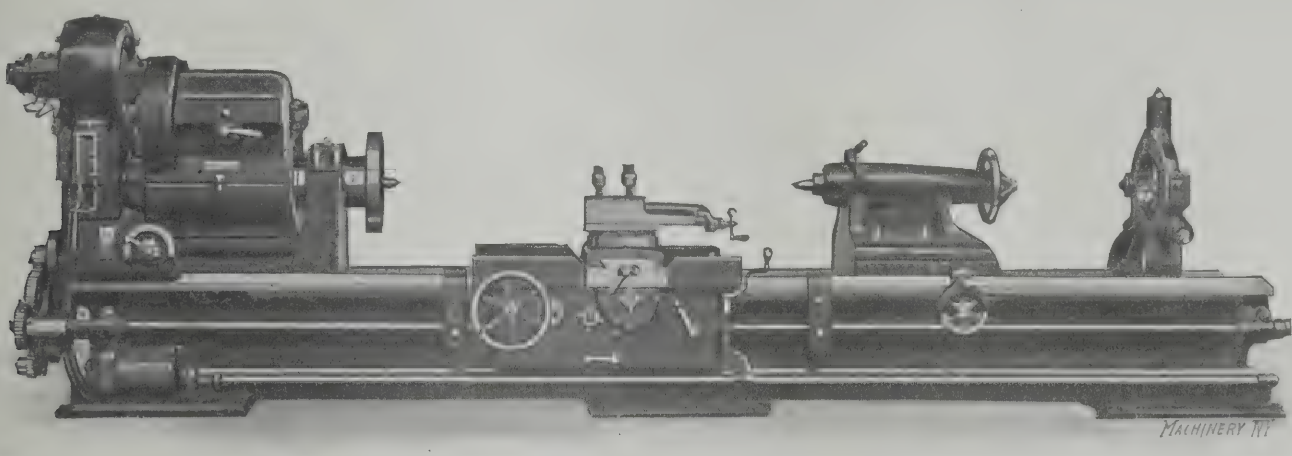


Fig. 1. Heavy Motor-driven Lathe built by the Springfield Machine Tool Co.

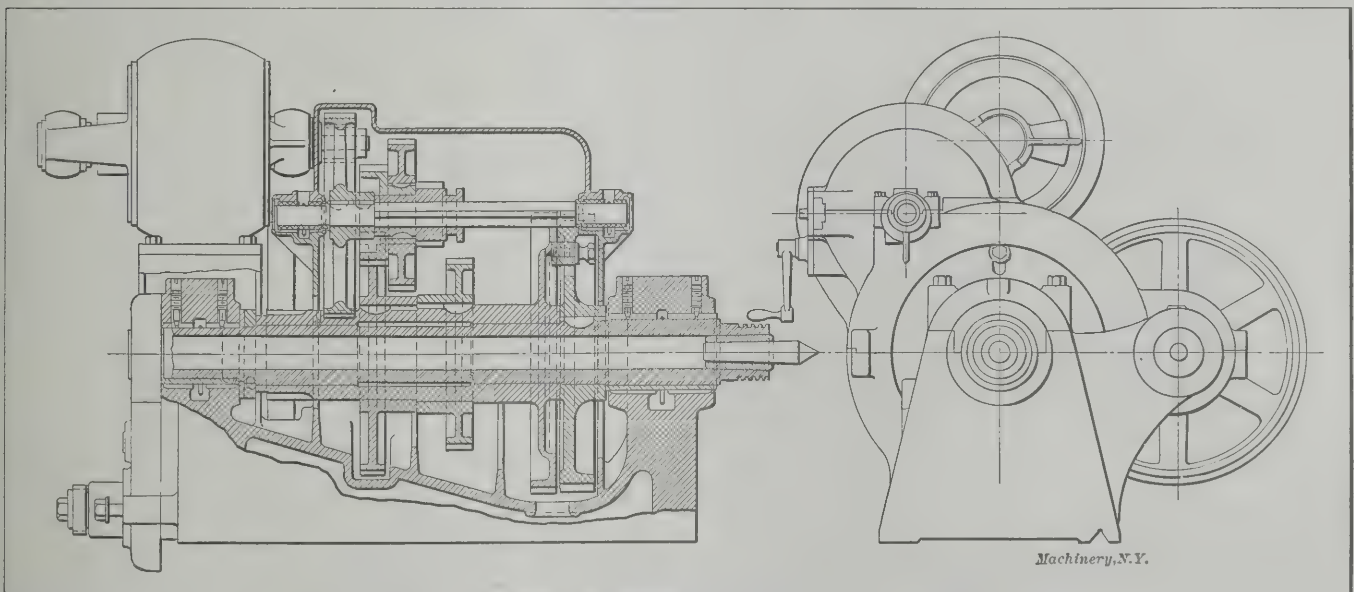


Fig. 2. View of the Headstock of the Springfield Motor-driven Lathe showing Motor and Speed Change Mechanism

ALTERNATING-CURRENT PORTABLE DRILL

The direct-current type of breast drill which has been manufactured for some time by the General Electric Co., Schenectady, N. Y., has worked so satisfactorily that the company has now placed on the market a drill designed for an alternating current. This tool, which is illustrated herewith, while possessing the ruggedness of design required to withstand the hard usage incidental to its service, is constructed as lightly as possible, the weight being only 21 pounds. Lightness, of course, is a desirable feature in a tool of this kind. An indicating control switch for starting and stopping the motor, is located conveniently near the right handle so that it can be operated by the right hand without releasing the hole on the handle. This feature makes the control of the apparatus so simple that the entire attention may be given to the operation of the drill. This machine is equipped with a Jacobs chuck which will take drills up to and including ⅜ inch in diameter. Two knurled side handles and a breastplate, provide ample means for holding the tool securely in any position. Hand holes are provided which furnish a means of easy access to the commutator and brushes for inspection or repairs, when

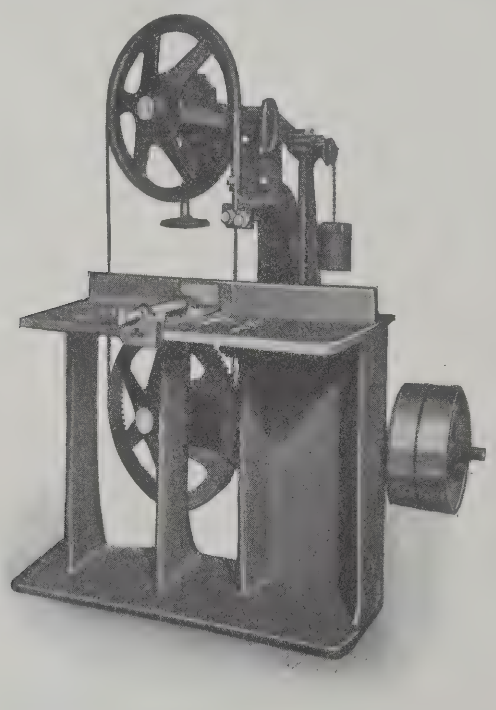
necessary. The drill is shown in the accompanying illustration with these hand hole covers removed. An idea of the capacity and adaptability of this tool may be had from the following approximate data: A hole three-eighths-inch in diameter and one inch deep may be drilled in cast iron in 27 seconds, or in machine steel in 95 seconds. The machine will

General Electric Co.'s New Drill for Alternating Current

also satisfactorily operate a ¾-inch wood bit. From these figures it is evident that much time can often be saved by the employment of this tool, as it will render unnecessary the moving of heavy castings to the stationary drill for many of the minor drilling operations. This machine is designed for operating on either a 110- or 220-volt, 60-cycle circuit, to which it may be quickly connected by simply screwing an attached plug into a standard lamp socket.

BAND-SAW MACHINE FOR CUTTING METAL

A band-saw that is intended for doing practically the same line of work in the machine shop as that which is ordinarily done by the power-driven hack-saw, is now being built by E. R. Klemm, 103 West Monroe St., Chicago, Ill. This machine, as the engraving shows, resembles somewhat in its design the



Metal-working Band-saw with Gravity Feed

band-saw of the wood-working shop. There are, however, a number of radical changes in its construction which were necessary to adapt it to the work for which it is intended.

The frame of this saw, on which are mounted the band-saw wheels, is free to swing about a bearing at its lower end, and it is by this movement that the saw is fed into the work. The feed is by gravity acting on the weight seen suspended by a chain at the rear. This chain, after passing over the pulleys shown, is attached to the swinging frame which is thus pulled forward. It will be noticed that the band-saw wheels lie in a vertical plane that is inclined considerably to the back or locating strip on the table against which the work is clamped. These wheels are located in this way in order that long stock will not come into contact with the idle side of the saw blade. Means are provided for changing the center-to-center distance of the band-saw wheels, to accommodate saws of different lengths and for varying the tension. The machine is strongly built, and it is provided with a large table equipped with a suitable vise for holding the stock. Practically any shape whether round, square or flat can be held securely and cut to any desired angle. The drive is through a shaft at the rear which has on its end a bevel pinion meshing with teeth cut on the lower band-saw wheel. Two disks, which are located a short distance above the table and on either side of the saw blade, deflect the latter so that it is square with the work.

The maker states that this saw cuts as squarely as any on the market, and also that it severs the stock with considerable speed and with a low power consumption.

BAIRD WIRE FORMING AND FERRULING MACHINE

In Fig. 1 is shown an interesting machine made by the Baird Machine Co., of Oakville, Conn., for the automatic production of pieces such as shown in Fig. 2. These pieces, which are bent in various shapes, have a ferrule around them,

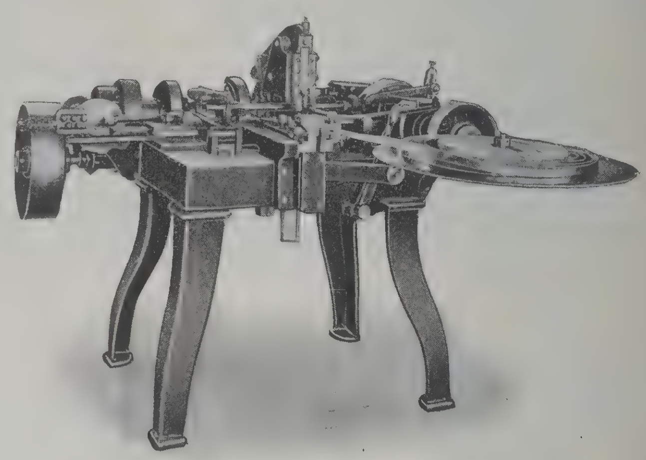


Fig. 1. Automatic Machine for Wire Bending and Ferruling

usually over the closed joint, made from strip metal. Such parts are used extensively for suspender loops, buckles, easel stands for photograph frames, etc.

The machine is a combination of two mechanisms, one of which performs the bending operations, while the other forms the ferrule. The action is entirely automatic. The wire is received from the coil, is straightened, threaded, cut off and formed; and at the same time a strip of sheet metal is received from a reel, is cut off, formed and pressed in place around the work as shown in Fig. 2. The capacity for completely ferruled work is from 60 to 80 per minute, according

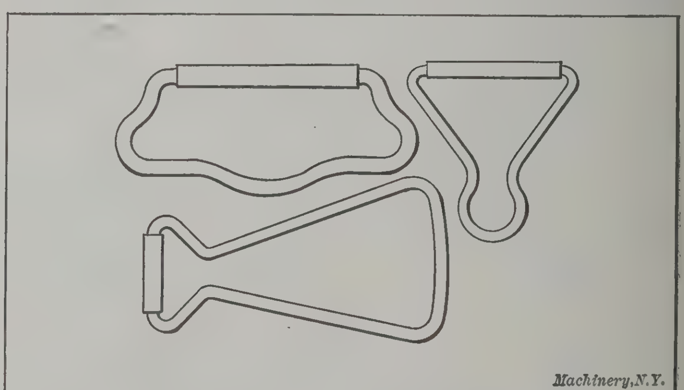


Fig. 2. Character of Work produced

to the size and shape. No further attention is required than that of keeping the machine supplied with strip metal and wire, and removing the finished product.

This machine is built in various sizes and for various styles of work. A high-grade of workmanship and construction is employed throughout, liberal use being made of hardened and ground tool steel for lining, tools, etc. All sliding surfaces are carefully scraped.

SPECIAL LE BLOND MILLING MACHINE FOR JIG BORING

The milling machine is now generally used in the tool room for the purpose of drilling bushing holes in jigs and fixtures, as well as for the machining of the various flat surfaces required in that work. The use of the miller is due to the convenient provision it offers for adjusting the work in two directions at right angles to the spindle, in the provision of a feed in line with the spindle, and in the rugged design and accurate construction, which permit much finer results to be obtained than would be possible on the ordinary drill press, even though supplied with the required adjustments.

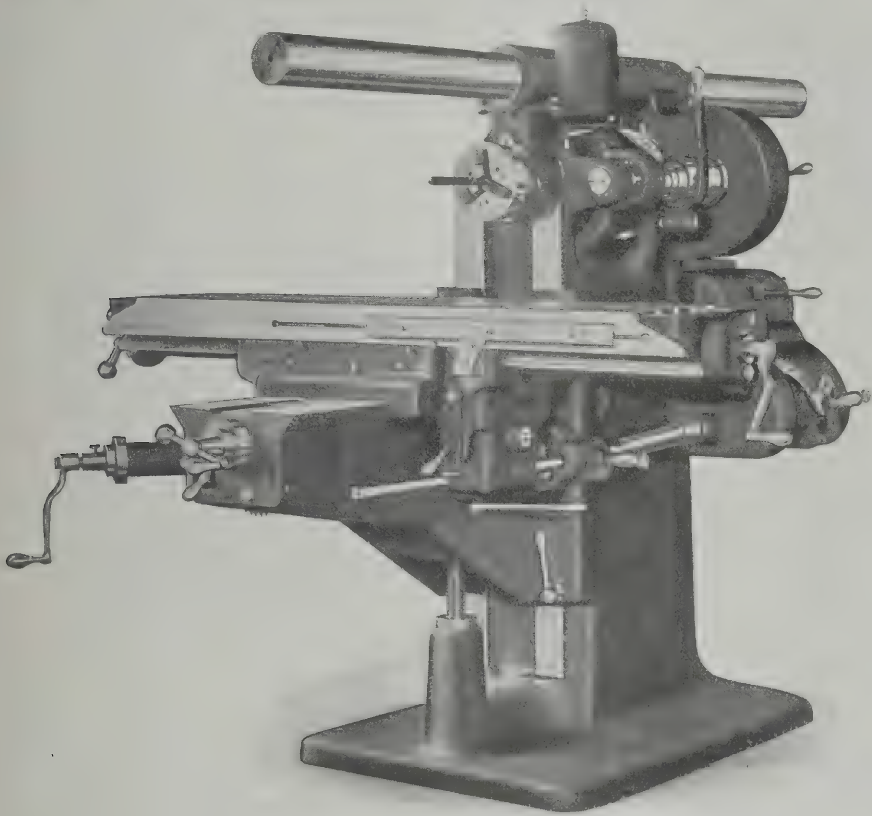


Fig. 1. Miller provided with Vernier Gages and other Conveniences for Jig Boring

The usual method of locating the holes for boring in the milling machine is by the use of ground bushings or "buttons," located by accurate measurements in the positions where it is desired to bore the holes. The buttons thus located are, in turn, lined up with the spindle of the machine by means of indicating devices, and the holes are then bored to the required size.

This button method is exceedingly accurate, but is correspondingly tedious. Another method which has sometimes been adopted consists in fitting accurate scales with vernier attachments to the miller, so as to read the various movements directly without requiring the setting of jig bushings or buttons with special instruments. This greatly increases the rapidity with which such work may be done, but, in general, it has not given as good results as have been obtained by the button method.

The R. K. Le Blond Machine Tool Co., 4609 Eastern Ave., Cincinnati, O., has, however, a special milling machine equipped with vernier scales, in which such care has been taken, both in design and construction as to insure close work. As a result the accuracy in jig and fixture work produced is high enough to meet all except what might be called extreme laboratory requirements, and this accuracy can evidently be obtained with a great saving of time and work for the toolmaker.

The salient features shown by an inspection of Figs. 1 and 2 are the heavy column and wide range of movement provided for the cross and table feeds, the special design of the automatic feed mechanism on the saddle, the increased stiffness of all the structural members and the modified arrangement of the handles, to permit the workman to use them while in a convenient position in relation to the work.

The spindle is unusually heavy. The front taper bearing is hardened and ground and runs in a close-grained cast iron box of special mixture. This insures a permanent bearing that will run indefinitely, showing no wear and requiring little attention. The rear journal is straight and runs in a bronze box fitted to a taper hole in the housing. This box is split and can be drawn into the taper to take up the wear on the rear journal. The end thrust of the spindle is taken by a hardened steel and a babbitt collar. An oil slot is milled in both boxes connecting with reservoirs in the column. These slots are filled with felt, through which the oil filters to the bearings. The arbor is driven by a clutch milled in the end of the spindle nose. An arbor bolt is provided which extends through the hollow spindle, and provides a convenient means of inserting and removing the arbors.

The cone is three-stepped, the largest step being 13 inches in diameter for a 3½-inch belt. The back gears are of the maker's double friction type, which, in addition to all the advantages of double back gears, provides a means for quickly stopping and starting the machine, a feature of equal value to the friction head on a chucking lathe.

Fig. 2. Side View, showing Arrangement of Adjusting Handwheels and Cranks

The feed box, which is of unit construction, is driven direct from the spindle with spur gears, doing away with all bevels or chains, and thus reducing the friction of the feed mechanism. Sixteen changes of feed are obtained by a system of tumbler and sliding gears, with only two operating levers. These levers are close together, and their movement

is such that a direct reading index plate enables the operator to tell at a glance the correct position for a given feed. The table feed is driven with a direct spur drive on the end of the saddle, instead of the usual construction of coming through the center of the knee and saddle, which further reduces the frictional losses in the feed mechanism. The reverse and trip for the table feed are operated by one lever, the mechanism being carried in a box on the end of the saddle. When the feed is tripped there are no gears or clutches running idle on the screw or in the saddle.

The table is unusually heavy, with arched ribbing to counteract the strains of bolting work on its surface. The bearing is taken on the outside of the dovetail and extends the full width of the table. Large oil pockets extend entirely around the table, and the oil is drained to each end, where it may be removed through cocks provided for that purpose. The table feed-screw is 1¾ inch in diameter, of coarse pitch, and geared 2 to 1 on the quick return. The thrust is taken on ball bearings at the ends of the table, and the screw is therefore always maintained under tension, regardless of the direction of movement.

The knee is made in box section, ribbed and braced transversely and laterally. The column bearing is extended up almost to the top of the table, which adds greatly to its rigidity. The saddle bearing is wider than the column bearing, giving support to the ends of the saddle. The cross feed screw is set in the center of the knee, overcoming all side strains and giving an easy movement. The saddle is of unusual length, and is braced its entire length with arched ribs through which the table screw passes. The taper gib for the table bearing is made with a tongue to avoid any tendency to lift. The lower gib as well as the gib on the column bearing are made with two angles, adjustment being effected with fine thread screws. Locking screws with fixed handles are provided on both gibs, which draws them in like wedges, and these provide metal to metal contacts the entire length of the gibs.

The machine has a longitudinal feed of 34 inches, a vertical feed of 20 inches and a cross feed of 18 inches. The unusual length of the cross movement is one of the chief advantages over an ordinary plain miller for boring jigs, as it permits the use of long boring bars for box jig work and for deep holes. In order to use the machine to the best advantage in boring, the cross feed is arranged in such a manner (see Fig. 2) that its movement can be controlled from the rear of the table—a position most convenient to the operator. This is accomplished by the introduction of the diagonal shaft through the knee which is connected to the cross feed screw at the front by means of bevel gears.

The longitudinal and vertical movements are fitted with vernier scales 24 inches in length, thus enabling the operator to lay off centers with extreme accuracy without the use of auxiliary measuring instruments. An interesting feature in connection with the completion of this machine was the testing of the accuracy of the screws. The vernier scales provided an ideal condition for such a test, which showed the screws so accurate that the error was invisible to the naked eye in a length of twenty inches.

MASSACHUSETTS FAN CO.'S "SQUIRREL CAGE" FAN

The increased use of mechanical ventilation and the extent to which motors and steam turbines are now employed, has resulted in what is called the high-speed or multi-blade fan. This type, because of its high rotary speed, is, of course, for the same capacity, smaller than the older types, for, naturally, the higher speeds make possible a reduction in the wheel diameter; in fact, this diminution in diameter was necessary to keep the rim velocity within practical limits. One of the greatest losses of power in the operation of a fan, is in the creation of an inlet velocity that is entirely destroyed before the air is delivered. In order to decrease this velocity, the area of the inlet is increased to as great an extent as the depth of blade will permit. It is well known that there is a very exact proportion existing between the volume of air delivered and the blade area of the wheel, and in order that the proper blade area may be maintained, a reduction in the depth of the blade must be accompanied by an increase in the number.

By increasing the size of the inlet, using many shallow blades in place of a few deep ones, and increasing the rotary speed, a marked increase in the air delivered and a greater capacity in a given space has resulted. In fans of the older designs, commonly known as the "paddle-wheel" type, the blades were wide apart at the periphery and nearer together at the inner ends. With the blades arranged in this way, the greater density of air at the outer ends caused the formation

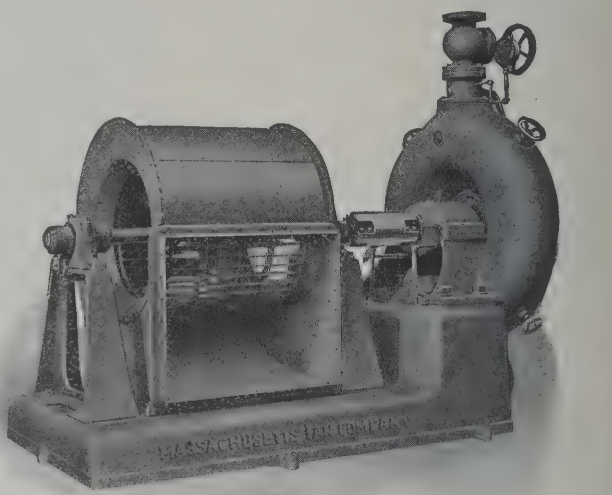


Fig. 1. Turbine-driven "Squirrel Cage" Fan built by the Massachusetts Fan Co.

of eddies and pulsations which reduced the efficiency and caused noisy operation at high speed. In order to reduce the effect of eddies, multi-blade fans were designed so that the air would be subjected to blade action during the shortest period possible. To accomplish this, blades were made very shallow.

The Massachusetts Fan Co., of Watertown, Mass., employs in addition to the blades around the periphery of the blast-wheel or cage, a few long and tapering blades, which extend toward the center of the wheel. These blades may be seen in Fig. 2, which shows a view of the blast-wheel for a double inlet blower. The theory is that these extra blades work with a scooping action which gives the entering column of air a slow whirling motion and a rapid radial motion toward the shal-

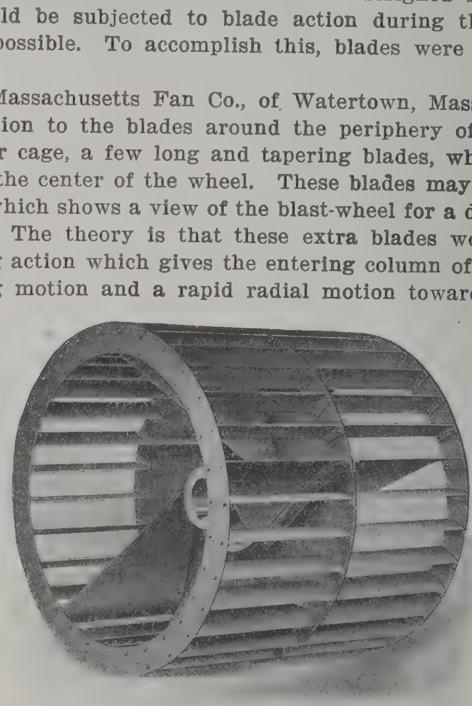


Fig. 2. Blast-wheel or Fan Runner of the Double Inlet Type

low peripheral blades, thus increasing the efficiency of the fan. Inasmuch as the centrifugal force acting on the entering column of air varies with the speed, the angle of these inner blades should be changed for different peripheral speeds. In order that fans working under different conditions will have a maximum of efficiency, the company referred to has developed three standard designs of the "squirrel-cage" type; these are as follows: Type A for the low peripheral speeds which have been found to be best adapted for building work, and for certain conditions for high pressures when the fans may be driven by a direct-connected steam engine; type B for higher peripheral speeds such as those of high-speed motors,

especially of the alternating current type; type C for very high speeds, as when driven by steam turbines.

One of these squirrel-cage fans of the double-inlet type is shown in Fig. 1 directly attached to a steam turbine.

SPECIAL WALTHAM BENCH LATHES

The Waltham Machine Works, Newton & Cutter Sts., Waltham, Mass., has for many years manufactured a line of bench lathes which are used for general manufacturing and special work, where parts to be made are small or require great precision in workmanship. These lathes are regularly provided with tailcenter, slide-rest, etc., and used in the same way as the largest size engine lathes in the machine shop.

A number of special appliances are provided for them, however, by means of which they may be converted into special machines. Some of these arrangements, of recent design, are herewith illustrated and described.

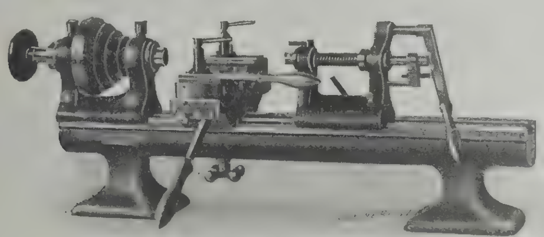


Fig. 1. Precision Drilling, Turning and Cutting-off Lathe

In Fig. 1 is shown a drilling, turning and cutting-off lathe, consisting of a plain head with a spring chuck, a double slide-rest and lever tailstock, mounted on a two pedestal bed. The movements of the various slides are controlled by lever, so that the action is very rapid. Stops are provided in all directions. The front toolpost on the cross-slide is mounted on a compound block which may be set to any desired angle, so that either cylindrical or taper surfaces may be turned and bored by the manipulation of the upper handle.

Fig. 2 shows a shortened one-pedestal lathe bed on which is mounted a headstock and a grinding wheel slide. This machine is intended for grinding small short work, one end of which is held in a spring chuck, while the other is supported by a center in a bracket attached to the back side of the headstock. A grinding wheel is mounted on a traverse spindle in a swivel support which may be set to any angle desired. An indicator is shown, which is provided with a sapphire point bearing against the work. This records the diameter, so that it is not necessary to stop the spindle and take measurements for every piece, this being done only occasionally.

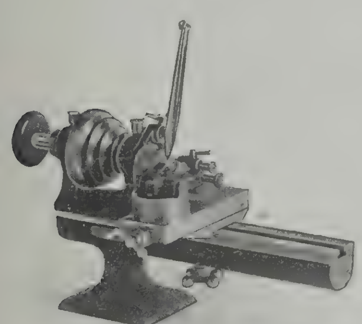


Fig. 2. Special Grinding Lathe with Self-contained Measuring Indicator

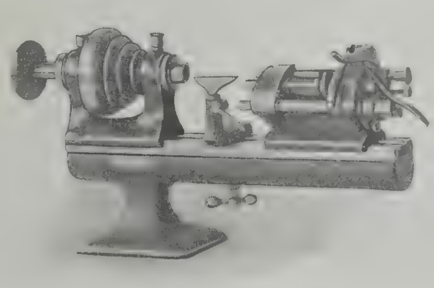


Fig. 3. Precision Lathe with Three-spindle Tumble Tailstock

The machine shown in Fig. 3 is a combination of a plain chuck headstock, a hand-rest and a three spindle "tumble" tailstock, mounted on a single pedestal bed. The center spindle of the tailstock can be driven by a belt, thus making it an excellent tool for spotting, drilling and reaming small holes.

The machine illustrated in Fig. 4 is provided with a headstock of special construction. The cross-slide is similar to that shown in Fig. 1. The lathe tailstock is of the "half bearing" variety, which may be provided with a multiplicity of spindles, each containing one tool of a number which it may be desired to use. Each spindle has its own stop, so that each may be set independently. To change from one to the other it is only necessary to pick out one tool and lay in the next in order. The headstock is of the slide spindle type, with a lever-operated chuck and wire feed. A two-step cone pulley is provided. This equipment is used in much the same way and for the same kind of parts that in larger work would be placed on a hand or automatic screw machine.

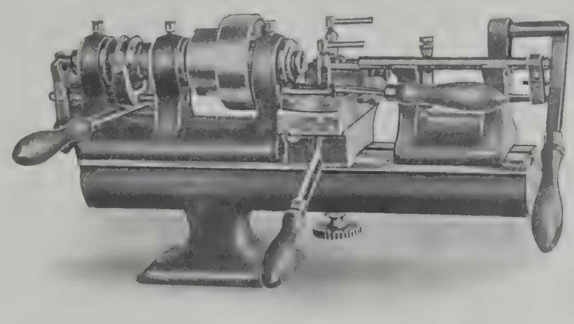
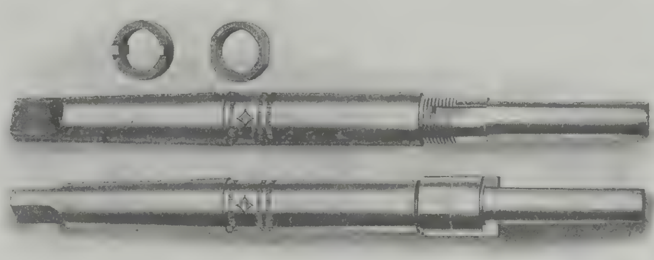


Fig. 4. Lathe with Double Lever Cross-slide and Half-bearing Tailstock adapted to Screw Machine Work

The various lathes here illustrated have, for the most part, a swing of 3¼ inches and a chuck capacity of 5/16 inch. Three other sizes are made, however, swinging 6¾, 7 and 8 inches, with ⅜, ½ and ⅝ inch chuck capacity, respectively. These lathes, with special equipment, are usually made only to order, though the makers occasionally have some of the parts in stock. As all the equipment of one size is interchangeable, any style of headstock can be used with any style of tailstock and slide rest, giving several other combinations in addition to those shown.

CLEVELAND TWIST DRILL COMPANY'S SHELL REAMER ARBOR

The Cleveland Twist Drill Co., Cleveland, O., is about to place on the market a new patented arbor for shell tools. The principal difference between this arbor, which we illustrate herewith, and the regular type is that it is equipped with an adjustable collar, provided with integral locking keys which slide in longitudinal keyways. This collar engages the shell reamers in the usual way. The arbor is threaded for a short distance to receive an adjusting nut which bears against the collar containing the locking keys. Perhaps the chief advantage of the new arbor is the quickness and ease with which it releases a shell tool, no matter how tightly it may have become jammed on the arbor. This is accomplished by a turn or two of the adjusting nut, and without the necessity of removing the arbor or resorting to the vise and hammer methods which often cause considerable damage. Another decided advantage is that the collar can always be set so as to allow the shell tool to fit snugly on the arbor, and yet fully engage the collar keys.



New Cleveland Shell Reamer Arbor with Adjustable Locking Collar and Tool-releasing Nut

CINCINNATI-BICKFORD 2½-, 3- AND 3½-FOOT RADIAL DRILLS

The radial drilling machines made by the Cincinnati-Bickford Tool Co., Cincinnati, O., (formerly made by the Bickford Drill & Tool Co.), are well known in their general characteristics. The smallest sizes of this line (2½-, 3-, and 3½-foot) have recently been redesigned by the makers. The main characteristics have been retained and there is, in fact, com-

paratively little change in their appearance. Improvements have been made, however, throughout the whole structure and mechanism of the machines, radically affecting the strength, durability, convenience, accuracy and productive capacity.

The design has a column extending to the top of the sleeve, ribbed internally so as to furnish a high degree of stiffness. It is mounted on a base which has been considerably strengthened at the point where the flange is bolted down. The ring which supports the elevating screw and takes the weight of the arm itself, is now supported on ball bearings, greatly reducing the force required to swing the arm. The pipe section of the arm has been retained, giving a high degree of strength and stiffness. In fact, in the matter of the general structure of the machine, all that was good in the old design has been kept, with the addition of improvements that increase its efficiency.

The power of the drive has been augmented by putting on a larger driving pulley, giving, consequently, a greater belt capacity. The well-known form of gear box provided, allows changes to be made while the machine is running at a high speed, by the simple tossing of the lever from one notch to the other. This can be done without taking special precaution to prevent breakages. The settings for the different diameters of drills are given below the notches in which the change gear lever rests. Gears subjected to hard service are of hardened steel. The bevel gears transmitting the power to the column have been increased in size, so as to make them proportionate to the greater power transmitted.

The back-gears are located in the head. They are of simple construction, consisting of three gears and a clutch, and may be engaged or disengaged while running. The clutch is made of high-grade carbon steel and has hardened teeth. The gear-box and back-gears give twelve changes of speed, ranging from 38 to 356 revolutions per minute, making them correct for a cutting speed of 35 feet per minute for drills from ⅜ inch to 3½ inches in diameter. This increased speed range is a new feature in this design.

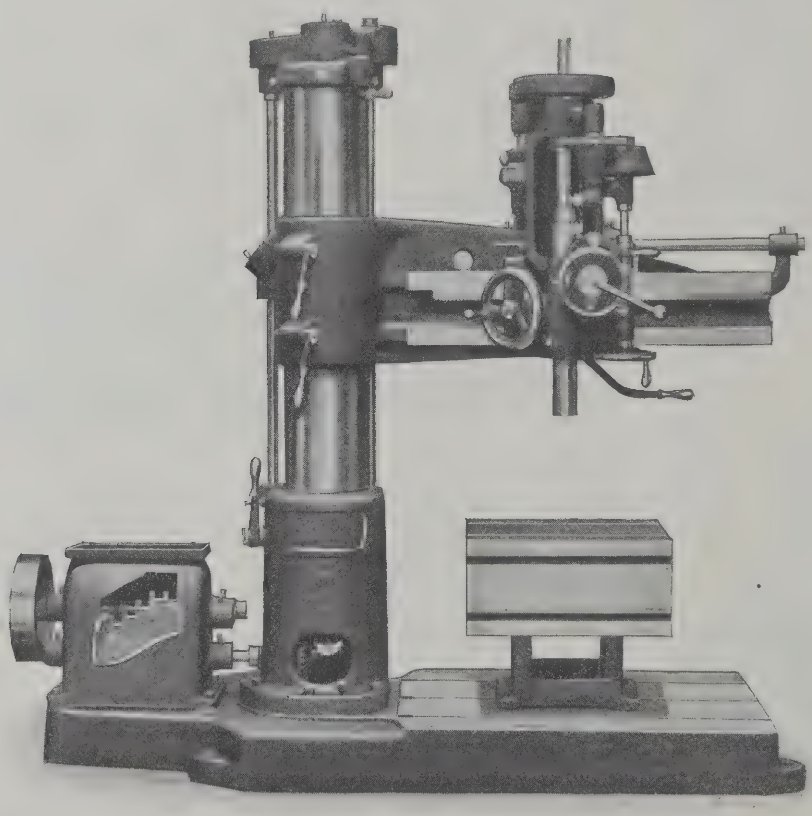


Fig. 1. Improved Design of Cincinnati-Bickford Radial Drill

The reversing clutch, the lever for which may be seen extending below the head in Fig. 1, is now expanded by a plunger and toggle-joint arrangement, whereby its capacity is increased many times over that of the wedge type of clutch formerly used. Adjusting screws permit the friction rings to be set to any tension desired. The reversing lever is employed for starting and stopping the machine as well, being within convenient reach from the operator's position.

The feed change device operates by means of a ball handle controlling a driving key mechanism. This gives four changes ranging from 0.008 to 0.020 inch advance per revolution of the spindle. Any one of these feeds is instantly available. The feed clutch is made of hardened steel. The thrust of the feed worm is taken on a ball bearing instead of on a fiber washer, reducing the power consumed by this member of the machine. The spindle sleeve also exerts its pressure on the spindle through a ball thrust bearing, reducing the power to run the machine nearly 22 per cent. This, with the increased diameter of the driving pulley, makes the machine capable of doing much heavier work than formerly.

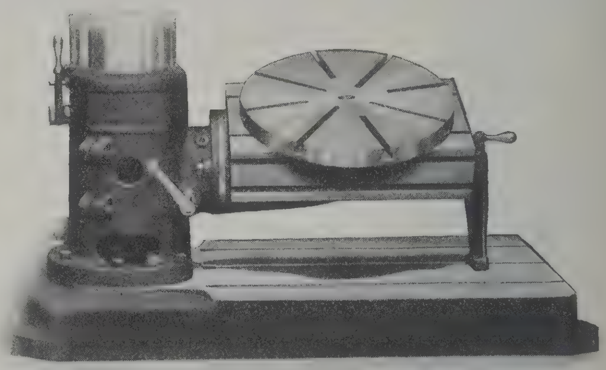


Fig. 2. Universal Swinging, Tilting and Rotating Work Table

The quick return handle on the feed pinion shaft is now provided with a toggle-joint type of adjustable clutch. This requires but a slight force to engage it, thereby avoiding the possibility of throwing the handle out of position by a sudden violent effort. Instead of graduating the spindle sleeve as formerly, depths are now read from a dial permanently located on the quick return head on the feed pinion shaft. The automatic stop is also made a part of the depth gage, and it may be set in position instantly without requiring trial cuts or measurements.

The guide on the top of the arm for the adjustment of the head is made flat instead of angular as usual, thereby allowing the head to move more easily, and minimizing the tendency for it to rock on the arm while the machine is in operation. The head clamping device has the important feature of tightening the gib in the head instead of lifting it away from it. This gib is now made taper instead of flat and is fitted with an improved adjusting device which eliminates the undesirable feature of having the weight of the head rest on the point of two screws. It also prevents the possibility of any end play.

Three forms of table are provided. Fig. 1 shows the box table clamped on the base of the machine, and provided with working surfaces on both sides as well as on the top. Fig. 2 shows a swiveling table provided with a wormwheel adjustment for setting it to any angle about a horizontal axis, the angle being indicated by a graduated ring of large diameter; a dowel is provided for locating it in the horizontal position. This design is also furnished, if desired, as a plain swinging table, without the swiveling attachment. The round work-table shown is a supplementary device which may be placed on the box, swinging or swiveling tables.

Special attention should be called, in Fig. 1, to the very complete set of gear guards provided. This is in line with the modern tendency of safe-guarding the workman. It has other advantages as well, however. It protects the gears from accidents, such as are particularly likely to occur in shops having traveling cranes. It prevents the throwing of oil over

the clothes of the operator. Besides all this, it adds so much to the appearance of the machine that it would seem to be a commercially profitable policy to provide complete gear guards on that score alone.

These machines are made in 2½, 3- and 3½-foot sizes, which dimensions give the radius of the circle to the center of which it is possible to drill on the base of the machine. The vertical adjustment of the arm is about 53 inches for each of the three sizes. The maximum height of the end of the spindle above the base is about 4 feet 3 inches. The vertical range of the spindle is 11 inches. It is bored for a No. 4, Morse taper. The weights of the 2½-, 3-, and 3½-foot machines with swinging table, are, respectively, 4,100, 4,250 and 4,400 pounds.

SIBLEY HIGH-SPEED GEARED DRILL

The Sibley Machine Tool Co., South Bend, Ind., makes a high-speed drill, which was illustrated in the department of New Machinery and Tools in the November, 1909, number of MACHINERY. This machine has recently been equipped with an all-geared power feed, which is illustrated in the accompanying engravings together with details of the speed change mechanism.

The gear-box for the feeds is mounted at the side of the lower spindle head, being connected in the casing at the top of the column with the horizontal spindle driving shaft. Four sets of gear ratios are provided, the change from one to the other being made by the sliding key mechanism operated by the knob plainly shown in the hub of the handwheel, which, it will be seen, places it within convenient reach of the operator.

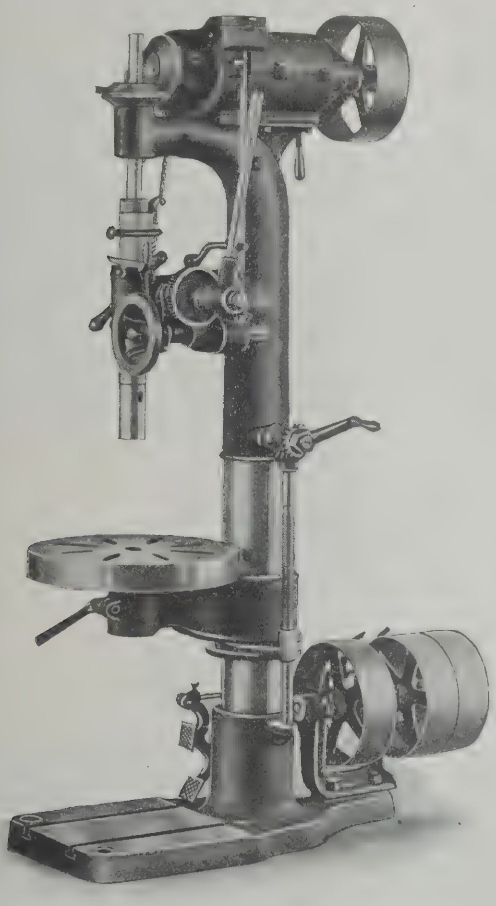


Fig. 1. Sibley Drill Press with Geared Quick-change Speeds and Feed

The usual drop worm mechanism is provided in connection with an automatic stop, actuated by an adjustable clamp dog on the spindle sleeve. A lever is provided for quick handling of the spindle for light drilling operations, while the handle at the left-hand end of the pinion shaft serves for the quick return movement.

The control of the spindle speeds will be understood by reference to Figs. 2 and 3. The constant speed driving pulley may be connected by either of two sets of gearing with the horizontal shaft at the left of the casing. The change from one set of gearing to the other is made by the lever shown in Fig. 2, just in front of the driving pulley at the top of the machine. This second shaft also carries a set of four gears meshing with a corresponding set of four gears on the spindle driving shaft, to which the driving bevel gear is connected. By the manipulation of the lever at the front, any of the four ratios provided may be obtained. The combination gives eight changes in all. The elimination of the cone pulleys permits the use of a wide belt running constantly at a high speed, giving greater power, besides having the obvious advantage of simpler and more rapid manipulation.

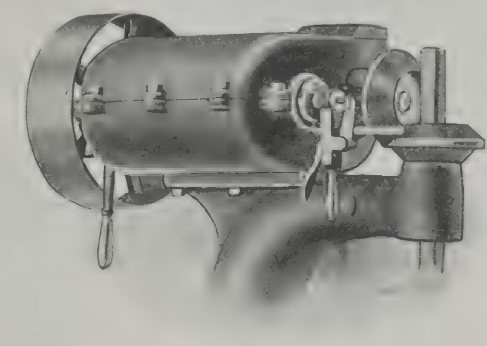


Fig. 2. Speed Change Box and Handles for Operating

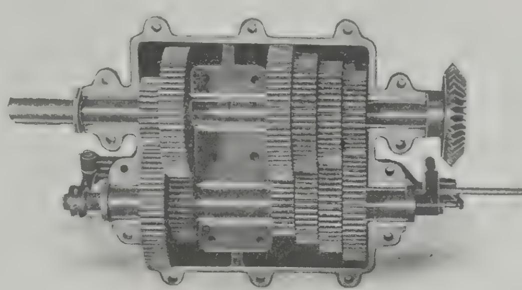


Fig. 3. Arrangement of Gearing in Speed Box

The bearings in the speed box are of bronze, the gears run in oil, and the whole construction is rugged and strong. All the changes of spindle speeds and feeds can be controlled without leaving the operator's position at the front of the table. The speed change is of the selective type—that is, the required speed may be obtained without running through the intermediate speeds and without stopping the machine. All the bearings are long, and the spindle and shafts are ground. The stiffness of the column is apparent in the illustration.

This style of machine is built at present only in the 22½-inch swing size. The total height of the machine is 6 feet, 5½ inches. The maximum distance from the spindle to the base is 39¾ inches, and from the spindle to the table, 19½ inches. The table is 19 inches in diameter. A No. 4 Morse taper hole is provided in the spindle. The eight speeds range from 99 to 600 revolutions per minute, while the feeds range from 0.0052 to 0.0169 inch per revolution. The spindle has a feed of 7 inches. The weight of this machine is about 850 pounds.

ROCKFORD ADJUSTABLE COLUMN GANG DRILLING MACHINE

In Figs. 1 and 2 is illustrated a novel design of gang drill, made by the Rockford Drilling Machine Co., of Rockford, Ill. As will be seen, the new feature is the provision made for adjusting the columns to different spaces along the planed top surface of the base. This allows the machine to be used, of course, for ordinary gang drilling operations, in which its merit over the use of four separate machines is principally that of compactness; but it makes it available as well for a large range of work which comes under the head of multiple spindle drilling—that is to say, it is adapted to the drilling of four holes in a line simultaneously on a given piece of work, or two holes in two pieces of work; and the spindles may be spaced to drill these holes at the different dimensions required.

The base has a planed top surface, provided with two T-slots in which each column is clamped by four stout bolts. A tongue in the rear T-slot serves to guide the columns and keep them in line. Each pair of columns is connected with

a screw by means of which they are adjusted along the top of the bed to the desired position. In this adjustment one column is clamped, while the other one is free to move under the influence of the screw. When this column has been moved to the desired position, it is clamped, in turn, and the other one is loosened and adjusted by the operation of the same screw. The minimum adjustment is 13 inches, center to center, for each of the pairs, and the maximum 30½ inches, center to center, between the adjacent spindles.

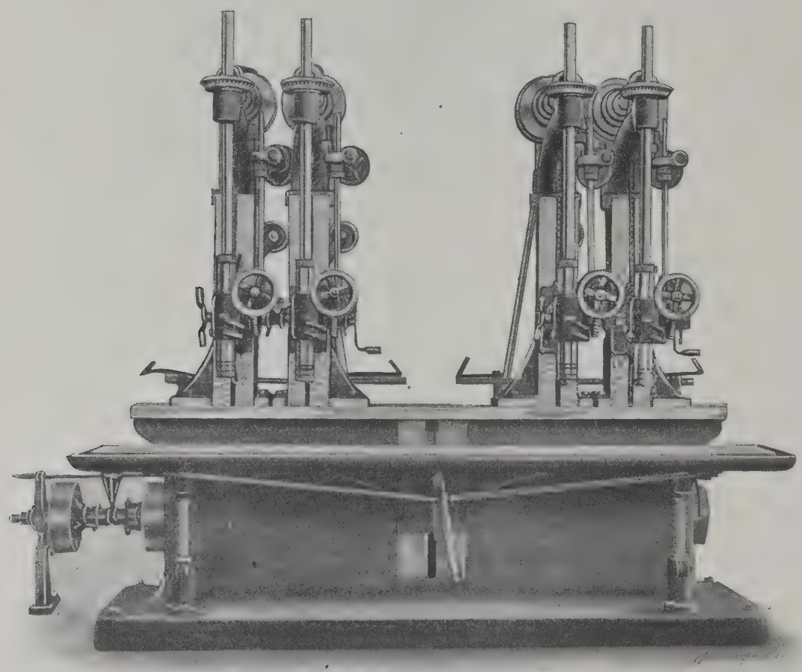


Fig. 1. A Four-spindle Gang Drill with Adjustable Columns

This adjustable column arrangement introduces a problem in the provision of a suitable belt drive, and bracing for supporting the belt pull. These problems have been solved in a way best shown in the rear view of the machine, Fig. 2. In place of the usual solid brace, running from the lower drive cone frame to the arm at the top of the machine, a strut has been provided which is pivoted at both top and bottom. At the lower end this is fitted into a socket where it is held by screws. Before the adjustment on the columns of the bed is changed, these screws are loosened, permitting the strut to slide freely in and out. When the adjustment has been made and the column is clamped in place, the screws are again tightened, to provide the compression strains due to the belt tension with a resisting member at this point. The tension under the varying adjustments is maintained by means of the idler pulleys shown, which work on the slack side of the belt, and may be adjusted to the belt's position.

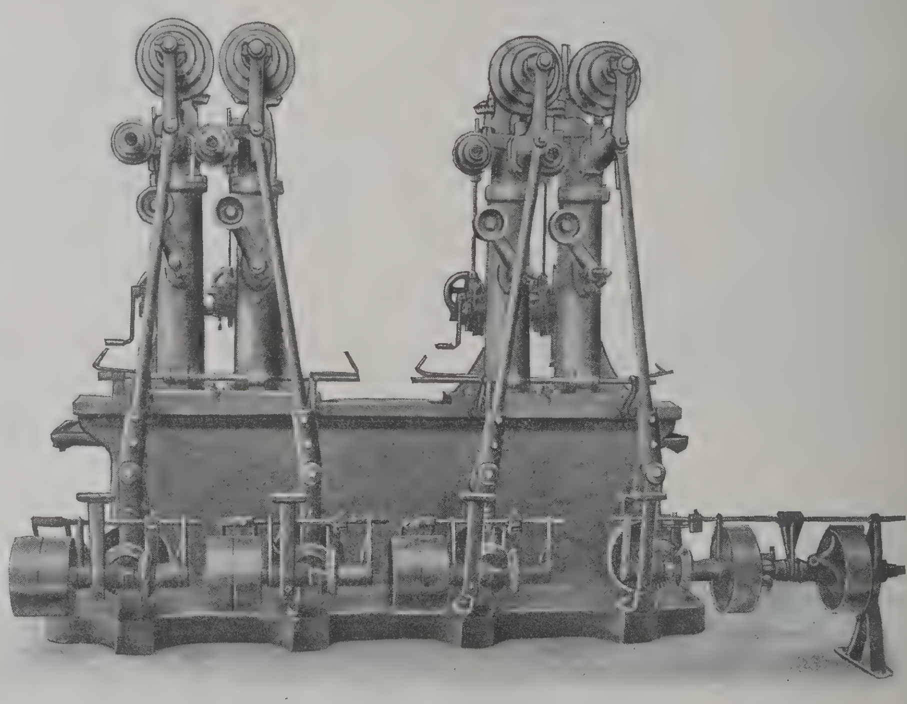


Fig. 2. Rear View of Gang Drill, showing Adjustable Back Braces and Belt Idlers

Each head is provided with a separate set of cone pulleys and a separate countershaft with its own tight and loose pulley and shifting lever, which is brought around to the front of the machine between the columns, where it can be readily handled by the operator. Power feed with automatic stop is provided for each of the spindles, thus making them independent.

The tool illustrated has the same dimensions and capacities for the individual spindles as the makers' regular 28-inch gang drill. Eight speeds are provided by the use of the internal back-gears, and there are four changes of power-driven feed. The table is mounted on two raising screws, geared together for changing the height adjustment. It is tongued and gibbed to the column, and may be rigidly clamped in place.

ALMOND GEARED DRILL CHUCK

T. R. Almond Mfg. Co., of Ashburnham, Mass., has made further improvements in the chuck with which its name has been connected for many years. The new design has the same internal construction as the original standard chuck, the improvements consisting in the application of a tightening device operated by a bevel pinion cut on the end of the tightening wrench. This construction is shown in the engraving.

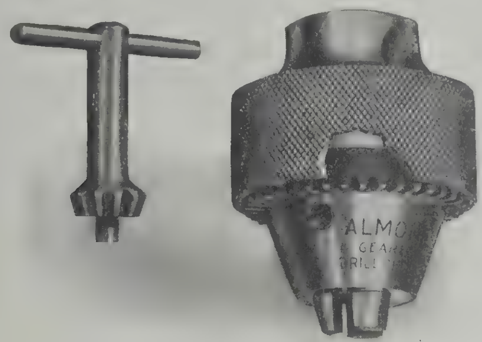
The main point of advantage in the new design relates to the gear teeth. Instead of being cut on the knurled sleeve as usual, they have been formed on the edge of the split nut or ring which operates the jaws. This nut is made of hardened and tempered tool steel, giving a great increase in durability and strength as compared with former designs in which the teeth are cut on ordinary mild, case-hardened metal in the sleeve. There is also an advantage in applying the tightening power directly to the nut, since it has been noticed that the frequent pressing of the sleeve on or off of the nut for cleaning purposes in the old design, tended to loosen the fit, so that the sleeve would slip when a firm tightening pressure was applied. The knurled sleeve is still, of course, available for quick adjustment by hand, the same as with the original construction.

Another improvement consists in bushing with hardened steel the holes in the body of the chuck, which receive the pilot of the pinion wrench, when the jaws are being tightened. These holes are subject in ordinary workshop practice to very severe usage, and by bushing them in this manner the fit of the gear teeth and the consequent satisfactory action of the chuck is prolonged indefinitely. This new design employs the same size pinion for both sizes of chuck, so that they are interchangeable. The wrench may, in fact, be chained to the drill press the same as the drift key, and be used for whichever size of chuck the workman happens to employ.

Improvements in general construction have resulted from the cutting of the teeth on the nut instead of on the edge of the sleeve. One result is the increase in the diameter of the nut and the consequent enlarging of the thrust area. The surfaces are thus better adapted to withstanding the pressure and

wear imposed on them when the jaws are forced out to receive the tool. The lubricant is also retained in these surfaces for a much longer period. This means that a greater tightening force may be safely employed, giving a higher gripping power.

The Almond chuck is made in three sizes. No. 1 takes up to 3/16 inch, No. 2 up to 5/16 inch, and No. 3 up to ½ inch diameter. The two larger sizes only are furnished in the geared style, as No. 1 size will hold securely by hand tightening anything up to its capacity. The geared and standard designs in the larger chucks are furnished at the same price. The pinion wrenches are made of high grade tool steel, tempered, and have a high durability, so that replacements are unnecessary. As in previous designs, long life and continued accuracy in the chuck itself have been secured by the high quality of materials employed, and a high grade of workmanship.



Geared Drill Chuck of Improved Construction

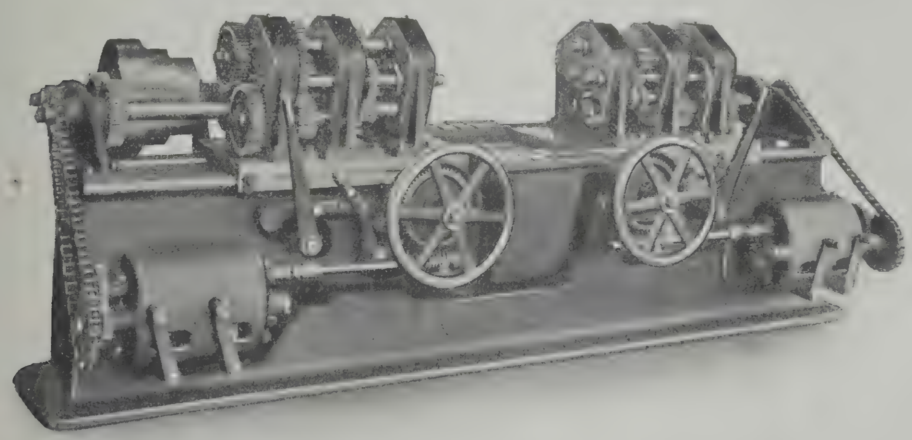


Fig. 1. A Transmission Case Boring Machine which provides for a Variety of Lay-outs

BEAMAN & SMITH TEN-SPINDLE TRANSMISSION CASE BORING MACHINE

The accompanying illustrations show a ten-spindle boring machine made by the Beaman & Smith Co., of Providence, R. I. It is intended for the special work of boring the shaft and intermediate stud holes in automobile transmission gear cases. These holes are bored from both ends of the case simultaneously, and provision is made in the arrangement of the spindles for different lay-outs for the positions of the shafts in the work. In the example shown the spindles are arranged for cases of four different designs, as indicated in Fig. 2; three of these are of the vertical type (Nos. 1, 2 and 4), while the other (No. 3) is of the horizontal type. The distances between the main shafts in Cases 1 and 3 are the same, and in Cases 2 and 4, but the lay-outs for the intermediate stud may be different for each, by having two of the spindles for these in one head and two in the other.

The general arrangement of the tool will be easily understood from Fig. 1. The machine consists of a long base provided with ways on its top surface on which slide the two spindle heads. These latter are each driven by separate cone pulleys and each is provided with its own feed mechanism, so that the two may be operated entirely independently of each other, both as to feeds and speeds. The work fixture is clamped to the top surface of the slide brackets which may be seen extending out front and back of the machine between the heads. Suitable T-slots and grooves are provided for locating it and bolting it down. The spindle head slide will be seen to extend forward of the heads, passing underneath the fixture when fed up to the work. The various boring tools are thus firmly supported, having a thrust directly downward onto the bed of the machine without any real overhang.

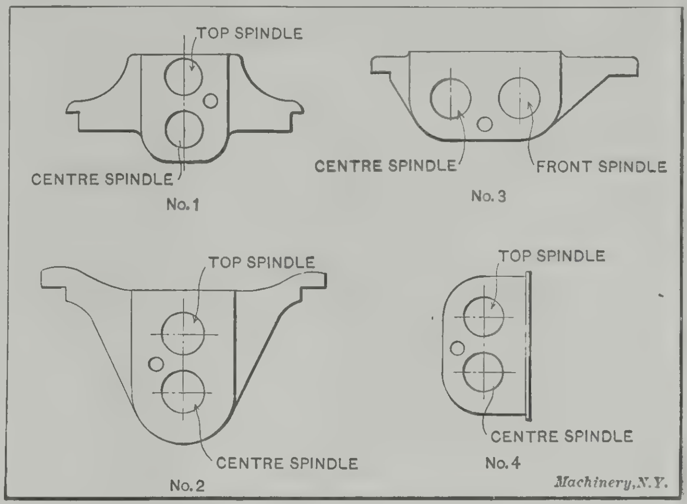


Fig. 2. Four Designs of Case for which Machine is adapted

Three threaded spindles and two smaller slotted ones are provided on each head. The former bore the holes for the main and secondary bushings, while the latter drill the holes for the intermediate studs. Not more than three spindles in a head are in use at one time. The ordinary arrangement would be to have three employed in one head and two in the other, since the intermediate stud hole is found at one end of the work only. For boring the vertical type of gear-box, the top and center spindles, as shown in Fig. 1. would be used, with the upper of the two slotted spindles. For the horizontal type, the center and front spindles would be used, with the lower of the slotted spindles for the intermediate stud. The arrangement of the intermediate stud holes may be somewhat different in the left-hand head, making provision for different lay-outs, as has been explained.

The method of driving the various spindles and of changing the connections for either the horizontal or vertical types is most plainly shown in Fig. 4. Gears E and F are driven from the pinion on the driving shaft geared to the cone pulley (see Fig. 1), and revolve continuously. Gear E drives shaft A, which has mounted on it a slip gear D, which may be changed to take the position D' if desired. In the position D,

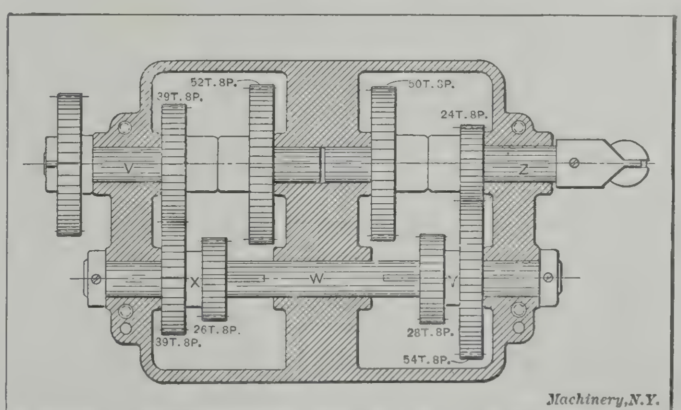


Fig. 3. Arrangement of Gearing in Feed Box

this slip gear engages gear G on the center spindle H. (It should be understood that this diagram is a development and not a plan.) In the position D' it drives gear J, which is connected to the top spindle K. This spindle, in turn, carries a gear L which, through intermediate gear M, drives pinion

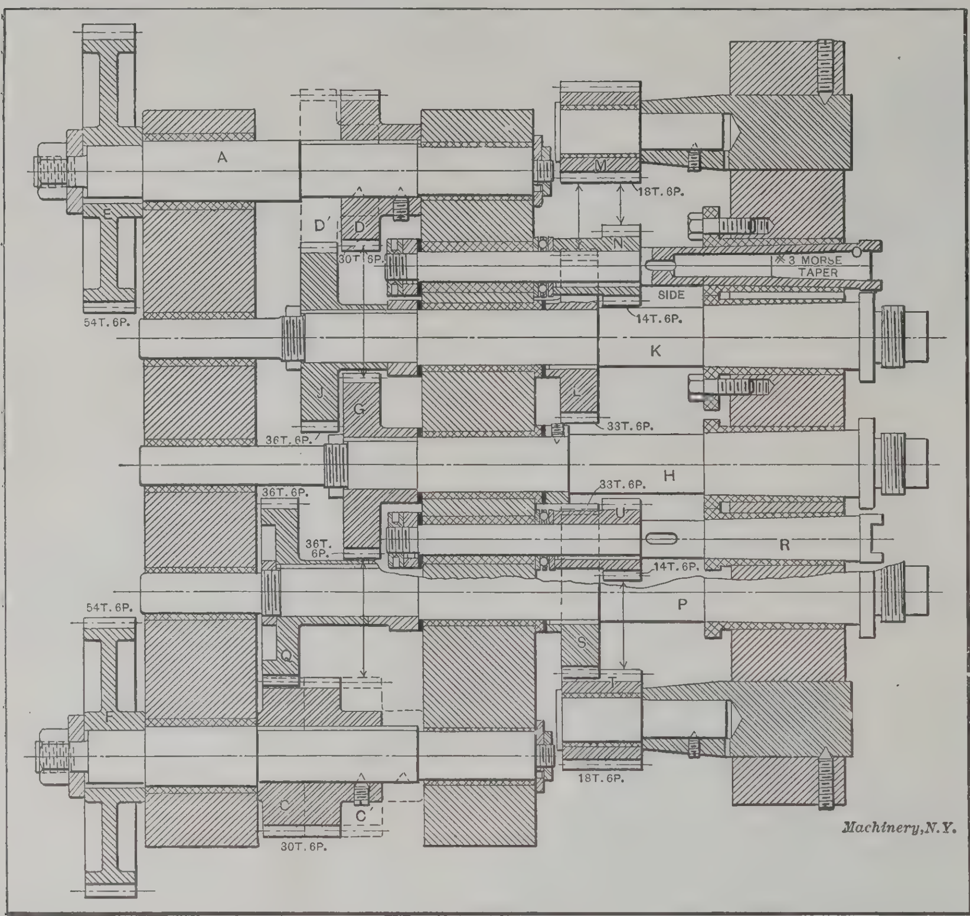


Fig. 4. Arrangement of Head Gearing, by means of which Spindle Movements are controlled

N on slotted spindle O. Thus in position D, center spindle H is driven, while in position D', top spindle K and slotted spindle O are driven.

In a similar manner, gear C has two positions. In the position shown, it drives front spindle P through gear Q and also slotted spindle R, which is connected with P through gears S, T and U. In position C', center spindle H only is driven through gear G.

It will be seen that in the position shown, with the slip gears at C and D, spindle H, slotted spindle R and front spindle P are being driven. This is the combination used for the horizontal transmission case. For the vertical case, the slip gears are changed to position C' and D', driving top spindle K, slotted spindle O and center spindle H. The three-step cone pulleys provide three changes of speed for each head.

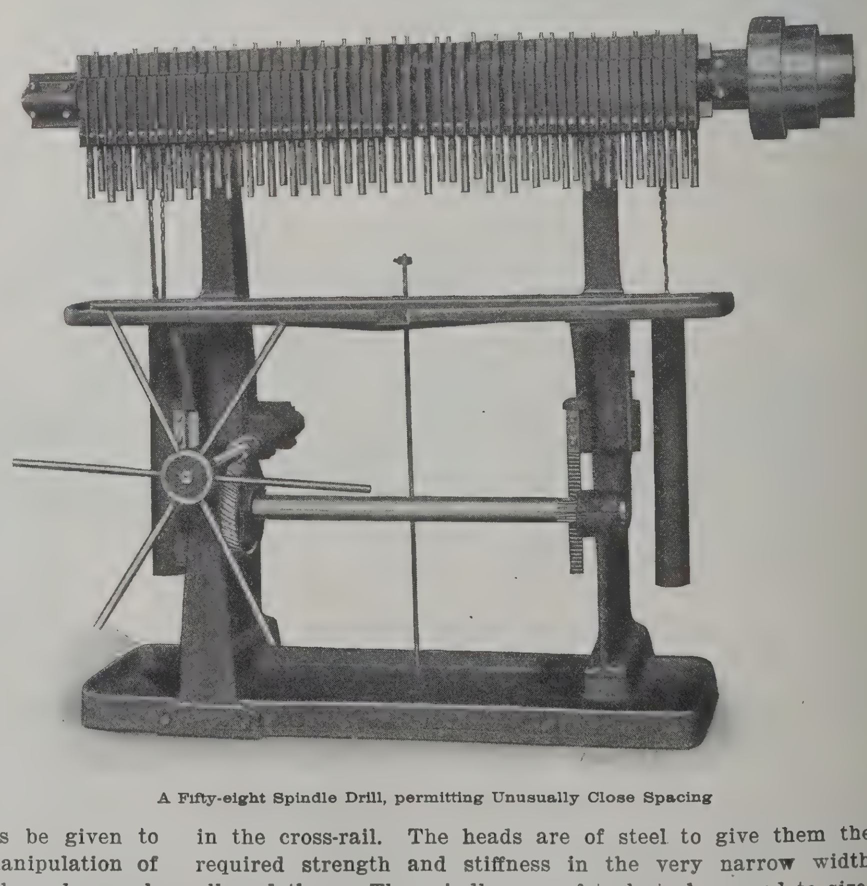
The gear-box gives four changes of feed; the construction is shown in Fig. 3. Motion is received by shaft V, which is provided inside the casing with two gears, one of 39 and the other of 52 teeth, as shown. On the intermediate shaft W is mounted the double gear X, either end of which may be engaged with the corresponding gear on shaft V by manipulating one of the handles shown at the front of the casing. At the other end shaft W carries a similar double gear Y, either side of which may be thrown into engagement with the mating gears on shaft Z by the operation of the second lever on the front of the casing. Four speeds may thus be given to shaft Z for each speed of shaft V, by the manipulation of the two levers of each gear-box. The feed is through a rack and pinion motion, driven by worm-gearing. An automatic stop is provided to arrest the feed, when the proper depth of boring has been reached. The length of feed is about two feet, and quick power movement is provided in each direction. The control handles are all in convenient reach of the operator. All feeds and speeds are positive. The machine is shown in Fig. 1 with all the gearing exposed. This is done simply to show the arrangement of the drive in actual use. Guards are provided which completely protect the gears from accident, either to themselves or to the operator.

This machine will, of course, be furnished with heads to suit any lay-out of transmission case. It weighs about 9,500 pounds.

MOLINE MULTIPLE SPINDLE DRILL

The multiple spindle drill made by the Moline Tool Co., of Moline, Ill., is unique in a number of particulars, especially in the closeness of spindle spacing permitted by the construction, the wide range of horizontal adjustment provided, and the ingenious arrangement of the drive. These characteristics are well illustrated in the special drill of recent design shown herewith.

The cross-rail at the top of the machine is provided with ways along which the narrow spindle heads are adjusted. Journal bearings are placed at each end for supporting a spiral gear which extends the full length of the ways. This spiral gear has further support besides that given by the journals, having a continuous bearing on its outside diameter in a seat formed



A Fifty-eight Spindle Drill, permitting Unusually Close Spacing

in the cross-rail. The heads are of steel to give them the required strength and stiffness in the very narrow width allowed them. The spindles are of tool steel, ground to size.

and run in bronze bushings. They are provided with ball thrust bearings. The lower bushing is threaded to give a vertical adjustment accommodating different lengths of drills. These heads are but $\frac{7}{8}$ inch thick and may be brought close up into contact with each other, so that the minimum spacing possible is $\frac{7}{8}$ inch.

The table is mounted on brackets gibbed to ways on the face of the housings at each end of the machine. The feed is by a rack and pinion movement. The pinion teeth are cut directly in the heavy feed shaft shown. In the particular case here illustrated, hand feed only is provided, being applied by a pilot wheel connected to the shaft by worm-gearing. Power feed will be furnished when desired. The table is counterweighted, and a stop is provided for its vertical movement, thus limiting the depth of holes drilled.

In the machine here illustrated, fifty-eight spindles are provided, but, of course, only as many of these will be furnished as are required by the purchaser. The adjustment range gives a minimum of $\frac{7}{8}$ inch and a maximum of 5 feet. The machine is intended for light drilling particularly, but where comparatively few spindles are used drills as large as 5/16 inch may be employed.

IMPROVEMENTS IN KINKEAD SHAFT LEVELING APPARATUS

In the June, 1909, issue of MACHINERY, we illustrated a line of shaft leveling apparatus made by the Kinkead Mfg. Co., 7 Water St., Boston, Mass. This apparatus consists essentially of a special architect's level, a portable target hung from the shafting to be lined up, and a fixed target attached to a wall or other convenient permanent support. A line is established between the level at one end and the fixed target at the other. The portable target is moved along the shafting, to successive locations near each of the hangers, in turn. Error in alignment is noted through the telescope of the level by direct reading on notched graduations provided in the target. The method of doing this is given in detail in the article referred to, and will not be enlarged on here.

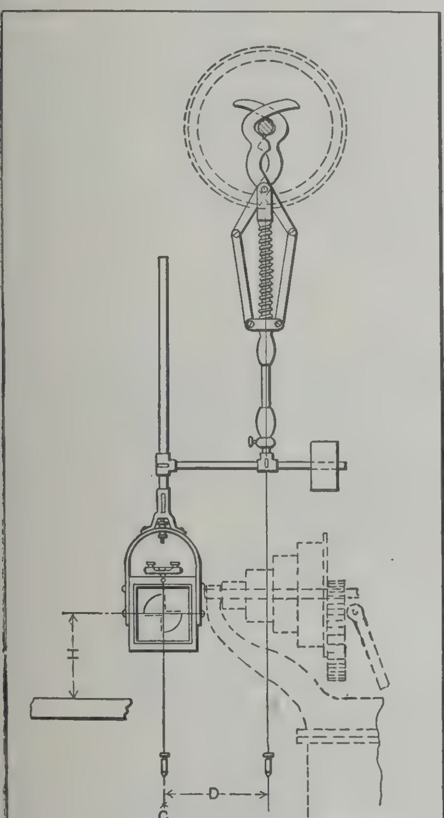


Fig. 1. Running a Line around Obstructions

The makers of this device have recently provided attachments and improvements which enlarge its range and increase its convenience, particularly in the aligning of shafting located in other positions than the usual one of suspension from the ceiling. The various attachments and methods of using them are illustrated in Figs. 1 to 4, inclusive.

Fig. 1 shows a difficulty occasionally met with. In this case, owing to the location of machines or other obstructions, it is impossible to run a straight line directly beneath the shafting, so offsetting the line has to be resorted to. In this case a special offset fixture is provided, as shown, with an adjustable counterweight which is used to bring the device into plumb in the vertical position. The vertical plumb-bob is used as in the regular apparatus to determine when this vertical position has been obtained.

Occasional cases are found in which shafting is laid in pits or beneath the floor. Provision for lining up shafting thus located is shown in Fig. 2. Here the portable target is reversed, being supported in this upright position by an adjustable leg at the side, as shown. The plumb-bob also has to be reversed, of course, being hung from the target itself.

For shafting located in pillow blocks on piers, the arrangement shown in Fig. 3 is employed. This is preferable to the vertical arrangement shown in Fig. 2 since this shafting is usually very heavy and the pulleys on it large, and the horizontal position enables the operator to work from the floor.

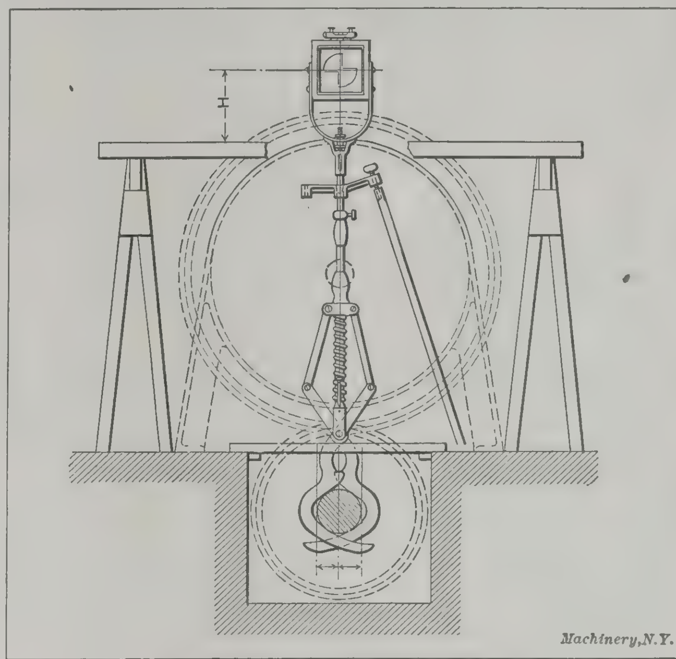


Fig. 2. Lining up Shafting carried in a Pit

The spirit level is attached to the face of the target by means of a special casting designed for the purpose. The target is supported by means of the rod shown, on which the adjustable thumb-screw rests.

It is common in a great many industries to arrange machines on benches, and drive them from a lineshaft beneath. For such work the arrangement shown in Fig. 4 may be employed. The portable target is mounted in fixtures which bring it at right angles with the clamping mechanism and bring it in a suitable place for working the architect's level and the fixed target.

All the various arrangements described provide for the accurate locating of both the level and the fixed target in positions convenient to the operator, and by means which permit

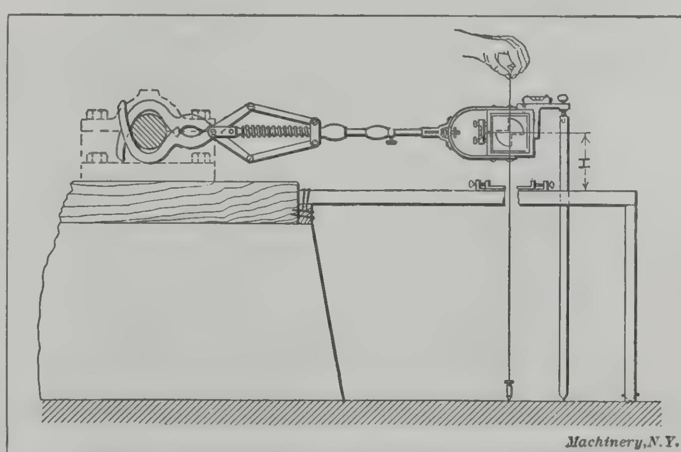


Fig. 3. Application to Shafting carried on Pillow Blocks

of the accurate alignment of the shafting. It will be remembered in connection with the former description that the jaws for gripping the shafting are so designed that they will clasp varying diameters without making any difference in the distance from the center line to the center of the target, as they automatically compensate for changes of diameter.

This equipment will be found useful in other ways. It may be employed for running lines of shafting through walls, or for setting up counter- or jack-shafts. It is also applicable to such jobs as the grading of steam and water pipes, the setting up of machinery, and the common problems in surveying

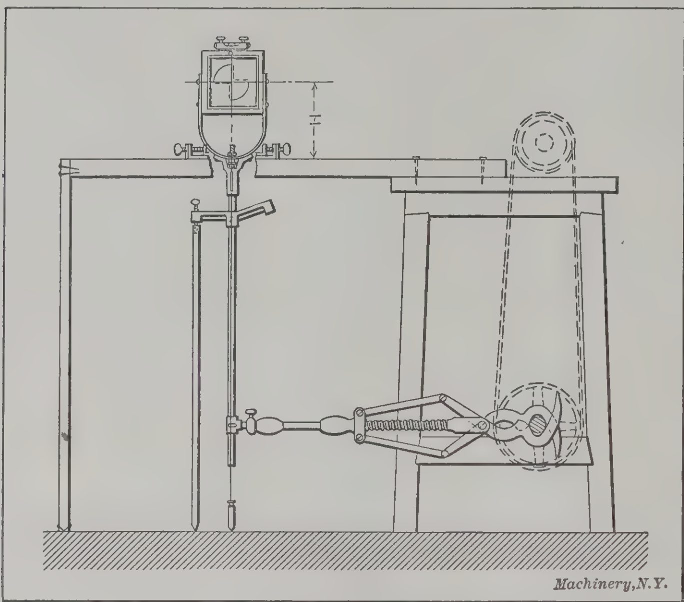


Fig. 4. Special Attachments for Lining up Shafting Mounted under the Bench

met with around manufacturing plants. This apparatus is now in use in many large and important mills and manufacturing establishments. It has been found that the accurate testing and maintenance of alignment in line shafting results in a surprisingly large saving of power, and the consequent avoidance of much trouble and expense.

PRENTICE 12-INCH GEARED HEAD REVERSING LATHE

The Prentice Bros. Co., of Worcester, Mass., has built for a number of years a geared head high-speed lathe, which has come into extensive use. The headstock provided with this lathe gives eight spindle speeds, any of which may be obtained while the lathe is in motion, since the changes are made by means of friction clutches of special design, operating without shock or danger to the gears. The arrangement is

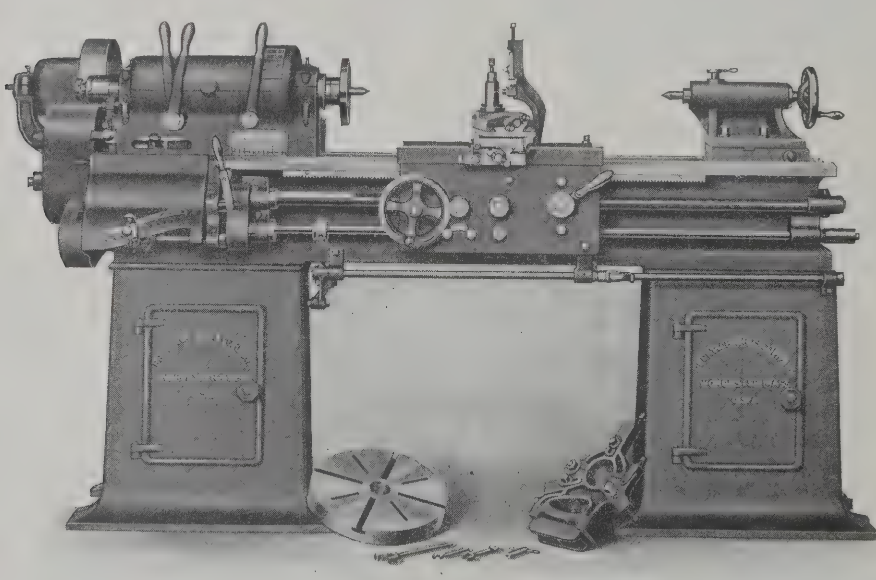


Fig. 1. Geared-head Prentice Lathe with Reversing Mechanism incorporated

such that it is impossible to engage two conflicting gear ratios at the same time. The advantages of a constant speed pulley drive of this kind are now well understood, in the matter of giving a constant belt horsepower at any speed throughout the whole range. On this 12-inch swing machine, the belt has a capacity for about 10 horsepower when the countershaft is speeded at the proper rate of 400 revolutions per minute.

An improvement recently incorporated in the design of this machine is shown applied to the lathe in Fig. 1; it is illustrated in detail in Fig. 2. The improvement consists in doing away with the countershaft, by making the reversing mechanism a part of the headstock drive. This is located on the driving shaft and consists, as shown in Fig. 2, of three bevel gears and two friction clutches, together with a lever for operating them.

One bevel gear, *A*, is mounted on the hub of the driving pulley *B*, and when this is engaged to the driving shaft by clutch *C*, a forward movement is given to the spindle through driving shaft *D*. For reversing the spindle, clutch *C* is disengaged and *E* is engaged, so that the spindle movement in the opposite direction is transmitted through gears *A*, *F* and *G*. These bevel gears transmit power, it will be seen, only when the shaft is reversed for threading or similar work. The lever for operating this reversing mechanism is located on and travels with the apron, so that no matter how long the lathe bed may be, the operator always has immediate control of the starting, stopping and reversing of the lathe spindle.

With this reversing mechanism, the countershaft becomes unnecessary, thus saving the two pulleys, shaft, clutches and hangers usually required when using a double friction countershaft. Whenever it is convenient, the lathe may be located underneath line-shafting and belted directly to it.

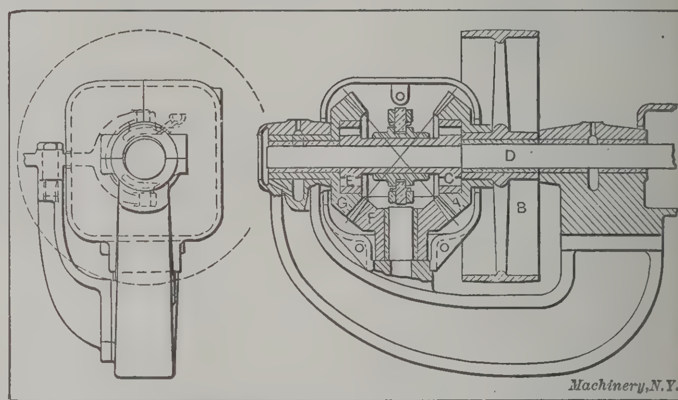


Fig. 2. Arrangement of Gearing and Clutches for Reversing

This construction also has advantages in the application of motor-drive to the lathe; the only additional mechanism that has to be furnished in this case is the motor itself. This is mounted on a bracket which is bolted to the rear side of the head-end cabinet leg. The motor is bolted directly to the driving pulley of the lathe. Provision is made for adjusting the height of the bracket and the tightness of the belt. One of the greatest objections to motor-driven lathes in the past has been the delay in obtaining the motors. This construction will do away with practically all trouble from this source, as any standard type may be used.

As mentioned, the lathe is practically of the same mechanical design as those previously built. It has, however, been redesigned throughout with the idea of making it heavier and capable of more severe service. The carriage is rigid, with an unusually stiff bridge, has a long bearing on the V's and is gibbed to the bed. The end thrust of the spindle is taken by a step bolted to the end of the headstock and entirely independent of the spindle bearing. A gear mechanism is furnished which permits the instantaneous change from one feed to another. There are 44 ratios available for screw cutting, ranging from 4 to 60 threads per inch. The index plate provided makes these changes so simple that an inexperienced hand can operate the mechanism without danger of mistake. An automatic stop to the feed is provided, which disengages a clutch on the feed rod at any desired length of cut.

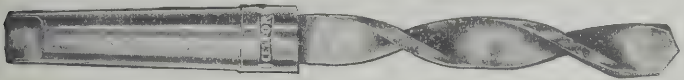
Large and small faceplates, center-rest and follow-rest, and

the required wrenches, are supplied with each lathe. When specified, the makers will supply at extra cost, taper attachment, countershaft (either of the tight or loose pulley styles) and electric motor attachment of any style or make of motor. The net weight of the machine with a 6-foot bed is 2,065 pounds.

CELFOR TAPER SHANK TWIST DRILL

The Celfor Tool Co., of Buchanan, Mich., has for some time past been supplying a drill made from a flat bar of high-speed steel. These drills are twisted while hot in especially designed machines. The resulting form has an increase of torsional strength of nearly 50 per cent over that of the flat bar from which it is made.

This drill has previously been left with the flat tang, and so has required a special form of drill chuck. The manufacturers are now, however, furnishing it with standard Morse

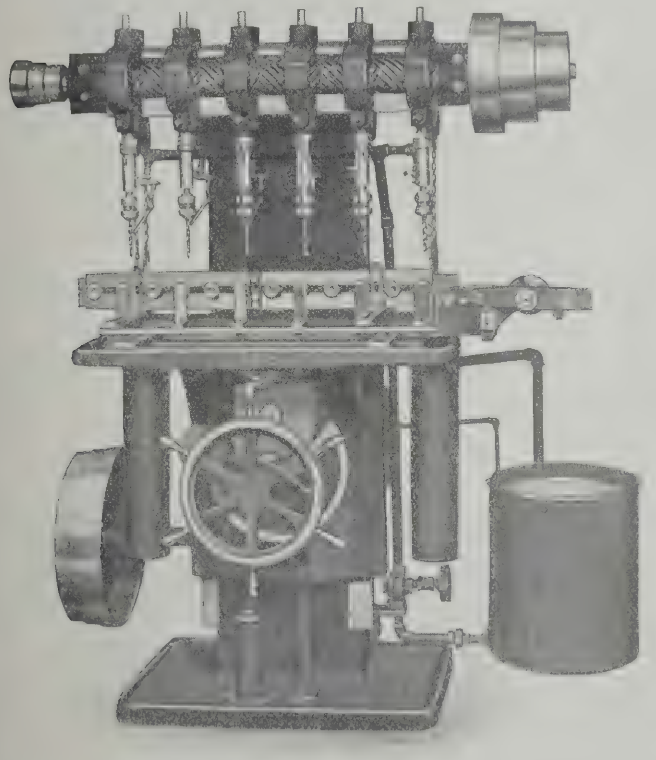


Celfor Drill, Twisted from Flat Stock, and set in Taper Shank

tapers, so that they can be used in the drill press spindle directly. The drills themselves, which are unchanged, are set into these taper shanks. The taper is one size larger than the standard employed for twist drills, so that ample driving power is assured, avoiding the difficulties met with in the failure of the tang on high duty work. As compared with the standard twist drill, the Celfor type is nearly twice as thick through the center, and has nearly 60 per cent more clearance space for the escape of chips. This results in requiring less operating power, owing to the relief from the clogging of the chips in a deep hole. The drills are accurately finished, being milled and ground in accordance with the best practice for such work.

MOLINE CONTINUOUS SIX-SPINDLE PIN DRILL

The machine shown herewith is made by the Moline Tool Co., Moline, Ill. It is designed especially for the rapid and economical drilling of cotter holes in brake pins, or for any



Six-spindle Drill with Shifting Work-holding Fixture

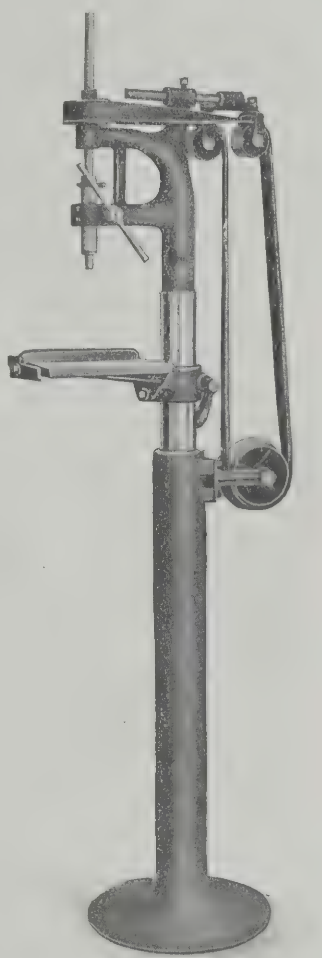
other similar work. Its special features are the provision of an adjustable jig for holding pins of different diameters and different lengths with precision, and also the arrangement for inserting and removing one set of parts while the others are being drilled. The machining operation is thus practically continuous.

The jig has twelve stations, while the machine has but six spindles. The operator places the pins to be drilled in every alternate station of the jig, which he then slides endwise to bring beneath the drill spindles, after which he starts the feed. While these are being drilled, the operator removes the work from the other stations and fills them again, ready to be shifted in their turn under the spindles as soon as the first lot is completed. The feed mechanism, as will be seen, is effected by a cam movement, so that the work-table drops instantly when the holes are drilled through. This movement is continuous, although it can be thrown out and the table lowered by hand if desired. There is an adjustable stop under the table so that it drops only far enough for the jig bushings to clear the drills. This can be dropped out of position and the table lowered clear down.

The spindle drive and the spindle head construction is along the lines of the regular multiple spindle drills made by this firm, and illustrated in connection with the fifty-eight spindle drill described elsewhere in this number. The spindles have ball thrust bearings and vertical adjustment for different lengths of drills. The machine is furnished with or without pump tank, piping, jigs and chucks. It may be used as a regular six-spindle adjustable drill when the special jig is removed.

TEN-INCH FLOOR DRILL

The bench sensitive drill press made by the Rockford Lathe & Drill Co., of Rockford, Ill., and described in the department of New Machinery and Tools of our number of November, 1909, is now furnished by the makers as a floor machine. The accompanying illustration shows it so arranged. It will be furnished with or without countershaft. It is provided with a belt-tightener and endless belt as shown. A tool-pan is mounted on the column, which does not appear in the engraving.



Ten-inch Sensitive Floor Drill

The spindle is 17 inches long and ¾ inch diameter. It is provided with a lever feed of 3 inches. The table has a surface of 8 by 8 inches and a vertical adjustment of 9 inches. The greatest distance from the spindle to the table is 12 inches. The driving pulley on the countershaft is 5 inches in diameter, 1⅝-inch face, and should run 550 revolutions per minute.

The advantages of the swiveling and tilting table and adjustable gage, furnished with this machine, have been described in connection with previous designs.

FRITZ "IDEAL" DRAFTING TABLE

The Fritz Mfg. Co., of 60 Alabama St., Grand Rapids, Mich., builds a line of drafting tables designated as the "Ideal," which is intended to meet the demand of draftsmen, students, etc., who need a good piece of furniture at a reasonable price. The construction is designed to be strong, durable and unusually rigid.

The standards are slotted and the cross-bar is tenoned into the slot. The cross bar is bored its full length for a rod, carrying a hand nut at one end, by means of which the legs are clamped in place. By loosening this adjustment the table

may be raised or lowered. When the nut is turned up, the table is held firm and rigid and does not allow the slightest vibration. The table can be tilted from a vertical to a horizontal position. This is effected by metal slides and braces. After the adjustment, it is clamped at both sides by a single thumb-nut at the right-hand side.

A Rigid and Inexpensive Drafting Table

When desired, a carefully finished tool cabinet will be furnished. This cabinet is provided with two drawers, the upper one of which may be drawn out to be used as a tray. These drawers are 6 by 20 inches; the upper one is two inches deep, and the lower three inches deep, inside measurement.

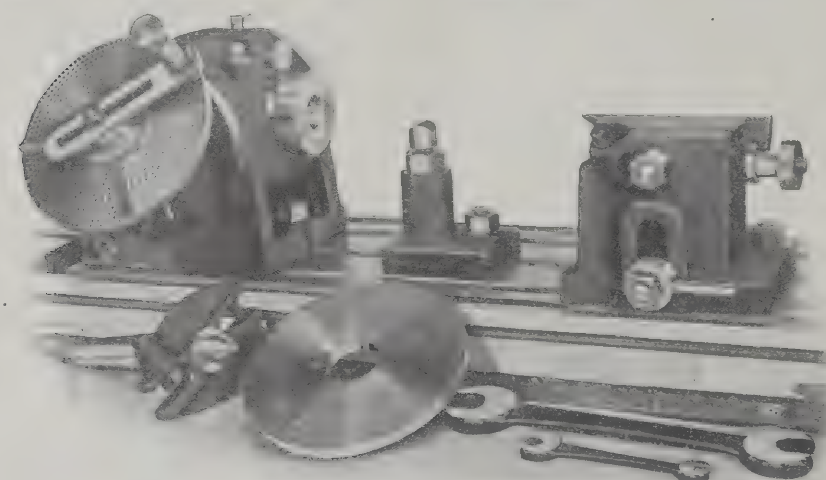


Fig. 1. New Type of Universal Dividing Head, brought out by the Kempsmith Manufacturing Co., Milwaukee, Wis.

The frame of the table is of hard wood. The top is ordinarily made of soft wood, but for the smallest size (22 by 30 inches it will be furnished in hard wood if desired. Four sizes are made, ranging up to 37 by 48 inches.

KEMPSMITH NEW UNIVERSAL DIVIDING HEAD

One of the most important accessories used with a milling machine is the universal dividing head, and many considerations must be taken into account in its construction. The dividing head is used frequently and on greatly varying classes of work, and the work done must, as a rule, be accurate. It is, therefore, necessary that the dividing head be carefully designed and accurately made; at the same time it must be of such construction that the requisite strength is provided. The accuracy must be preserved, facilities for proper adjustments must be included, and when in use it must be convenient to handle and operate, as well as universal in its scope.

An improved universal dividing head as illustrated in the accompanying half-tone, Fig. 1, has recently been brought out by the Kempsmith Mfg. Co., Milwaukee, Wis. In the design of this dividing head the various considerations referred to above have been given due attention. The dividing head is substantial and compact in its construction, and there is a notable absence of complicated mechanism.

Dividing Mechanism

It is evident that the most important feature of any dividing head is the dividing mechanism, and a large diameter of the worm-wheel is essential for accuracy. The usual method employed for making the worm-wheel of large diameter is to mount it at the extreme end of the spindle, practically outside of the main frame. This method, however, is objectionable because it brings the working strain on one end of the spindle, and the worm-wheel casing is in the way when work is to be done close to the head. On the dividing head shown in the illustrations, the worm-wheel is mounted centrally inside of the head, between the front and rear spindle bearings. It is pressed on the spindle and keyed, thus insuring a positive movement of the spindle when the wheel is engaged by the worm. The angular position has been adopted for the worm-shaft. It is at an angle of 36 degrees with the horizontal, which brings the point of contact of worm and worm-wheel correspondingly around at an angle with the vertical. This arrangement makes it possible to increase the diameter of the worm-wheel because the angular position of the worm-shaft and index plates avoids interference of the latter with the table. In the head of 10½ inches swing, the diameter of the worm-wheel is 5¼ inches, and in the head of 13¼ inches swing, the diameter is 6½ inches. Fig. 2 shows the rotating arm or block with the spindle and worm-wheel in place, and Fig. 3 the spindle and worm-wheel assembled. In Fig. 4 is shown a horizontal and vertical section of the dividing head, giving a general idea of its design.

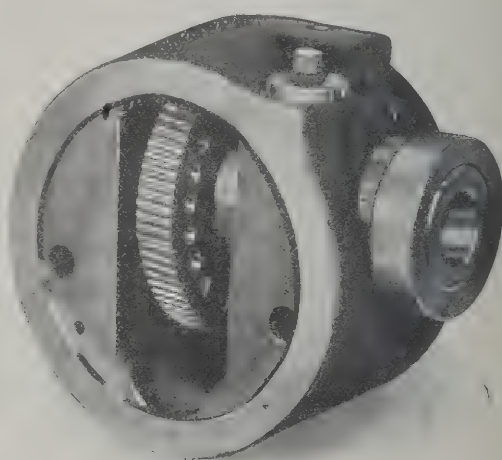


Fig. 2. Rotating Block of Kempsmith Dividing Head

As will be seen, the worm is in one piece with the worm-shaft, which is mounted in a long bearing extending up to the shoulder formed by the worm itself. This arrangement provides for a strong bearing support close to the point of contact between the worm and the worm-wheel. The worm runs

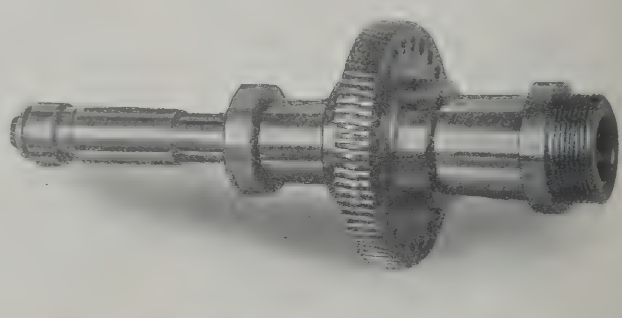


Fig. 3. Dividing Head Spindle and Worm-wheel Assembled

in oil, the oil pocket being shown in Fig. 3 and in the vertical section of Fig. 4. An outside adjusting screw is provided by means of which the wear between the worm and worm-wheel is taken up. This adjustment is in a straight line, perpendicular to the axis of the worm-wheel, and thus preserves the alignment and accuracy, even after repeated adjustments. When direct rapid indexing is required, the worm can be

easily disengaged from the worm-wheel. The arrangement for disengagement is entirely independent of the adjustment, so that this latter is not disturbed. Another advantage of the disengagement is that when tightening the nut on arbors put into the spindle, the worm-wheel teeth do not take the stress.

Range of Index Plates

Two index plates are regularly furnished, providing divisions for all numbers up to 60, and for all even numbers and all multiples of 5 up to 120, and a very liberal number of divisions between 120 and 400. Three specially high number index plates can also be furnished, providing 122 additional divisions between 61 and 400. These plates include all divisions up to 200, which are not obtained by the standard index plates. The arrangement of mounting the index plate at an angle permits of still larger plates being used, if for any extremely special case this should be required, without it being necessary to increase the swing of the dividing head to provide room for the larger plate.

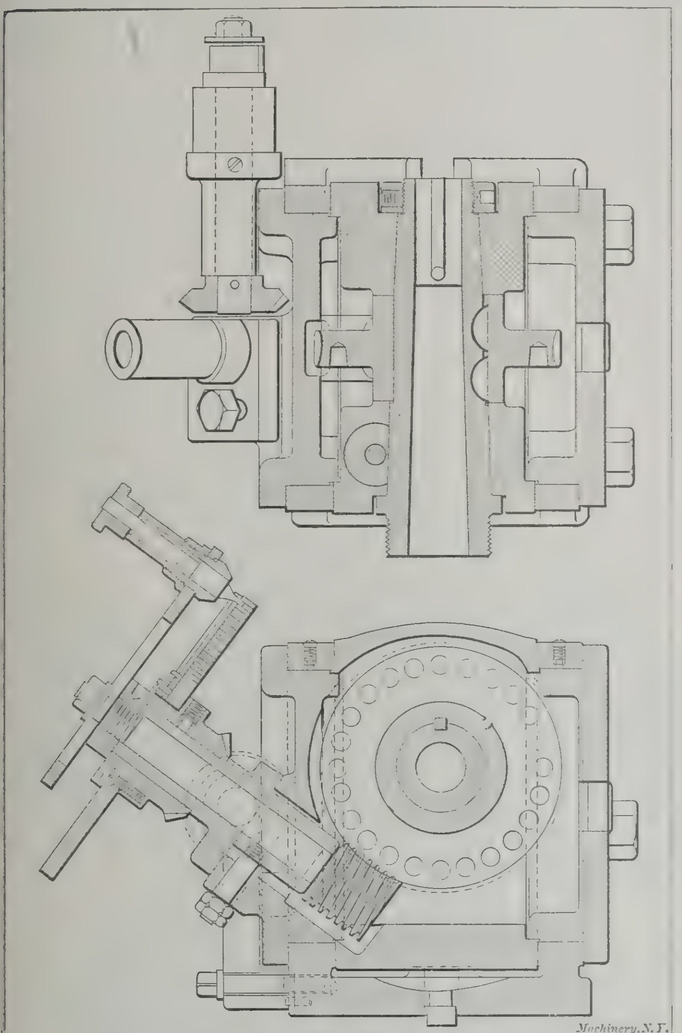


Fig. 4. Horizontal and Vertical Sections of Dividing Head

The index handle is mounted directly on the worm-shaft as shown in Fig. 5, so that its movements are directly transferred to the worm-wheel, leaving no chance for error or inaccuracy through a train of gears. The angular location of the index plate makes it much easier for the operator to see it clearly when indexing, because it is directly in his line of vision as he stands in his natural operating position. It is not required that he stoop down, as in the case when the index plate is vertical.

Direct indexing is easily accomplished with the worm and worm-wheel disengaged. A plunger engages a circle of holes in the front of the worm-wheel, as shown in the vertical section of Fig. 4. The spindle is graduated correspondingly on the front of the shoulder, so that the movements can be easily determined. This quick indexing is valuable for small numbers of divisions—for example, when milling hexagons, or the flutes in taps or reamers.

Spindle and Rotating Block

The spindle is of liberal diameter and is mounted in taper bearings provided with a simple but efficient locking device, as indicated by the clamping bushing in the horizontal section in Fig. 4. The taper hole and the threaded nose on the index head spindle are the same as on the main spindle of the milling machine with which the dividing head is regularly furnished. Thus all tools are interchangeable between the main spindle and the dividing head. A large hole runs clear through the spindle. The rear end is arranged to receive an extension stud which is used when the spindle is geared directly to the feed-screw. This arrangement is used when cutting spirals of very short leads as will be mentioned later. This stud is shown in place in Fig. 3. The rotating block which carries the spindle is capable of swinging through an arc of 150 degrees, from 10 degrees below the horizontal to 50 degrees beyond the perpendicular. It is firmly clamped in whatever position set by means of two large bolts with hexagon heads placed in the rear of the head.

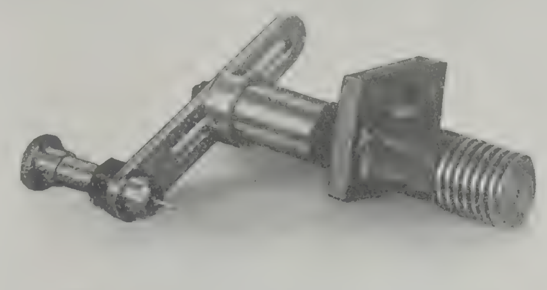


Fig. 5. Worm and Worm-shaft with Index Handle

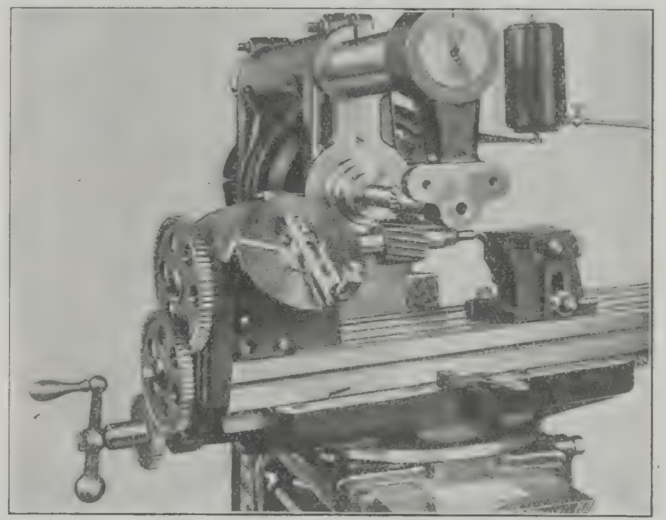


Fig. 6. Dividing Head arranged for Spiral Milling

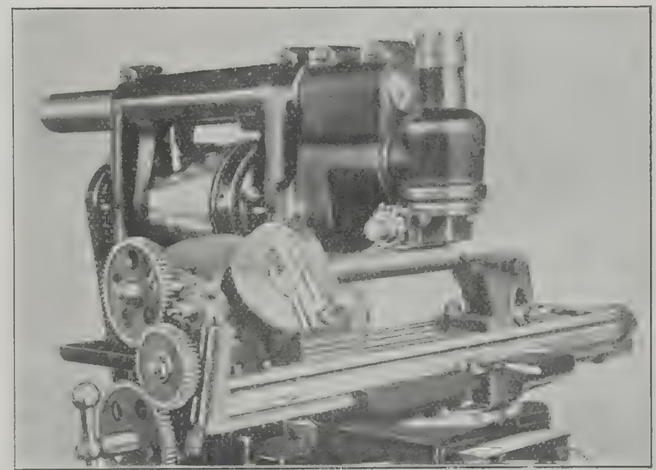


Fig. 7. Feed-screw Geared Directly to Index Head Spindle

Change Gears for Spiral Milling

Twelve change gears are furnished with the dividing head for spiral milling. The change gear bracket is quickly attached or removed. The drive from the change gearing to the

worm-wheel is through two miter gears, one being on the same stud as the last gear in the change gear train, and the other being attached directly to the index plate. In Fig. 6 is shown the dividing head arranged with a train of change gears in the usual manner for cutting a spiral, the work in this case being a spiral milling cutter three inches in diameter, 18 teeth, with 48-inch lead of spiral. When the lead is less than 1½ inch, the gear ratios become so high that too much

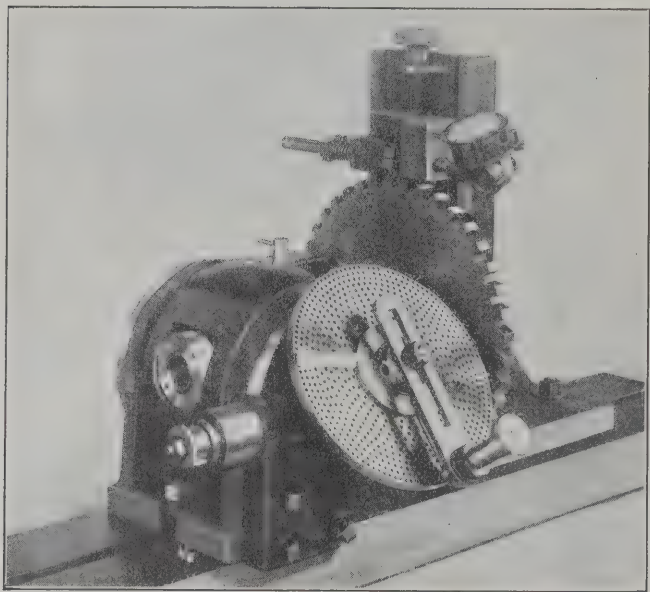


Fig. 8. Testing the Worm-wheel

power is consumed in transmission and these leads, therefore, cannot be cut in the usual manner. A very interesting method is, therefore, used for short leads, in that the gear train is led directly from the feed-screw to the dividing head spindle, as already mentioned, the extension stud being provided on the spindle for this purpose. A gearing arrangement of this kind is shown in Fig. 7, which also shows the use of the universal milling attachment when the angle between the cutter and the work is greater than that which can be obtained through the swiveling table. In the

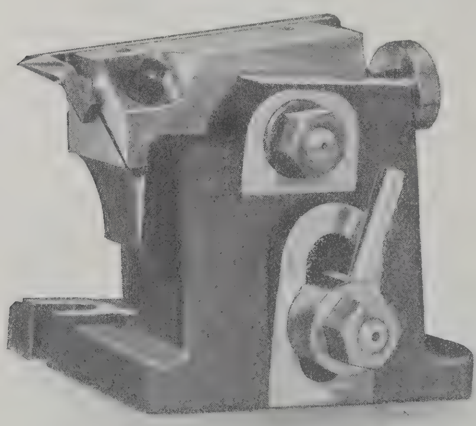


Fig. 9. Tailstock of Kempsmith Dividing Head

charts which accompany the dividing head, the gears required for leads from 0.120 to 1.500 inch are given for direct gearing, and for leads from 1.550 to 100 inches for gearing in the ordinary manner.

Testing the Worm-wheel

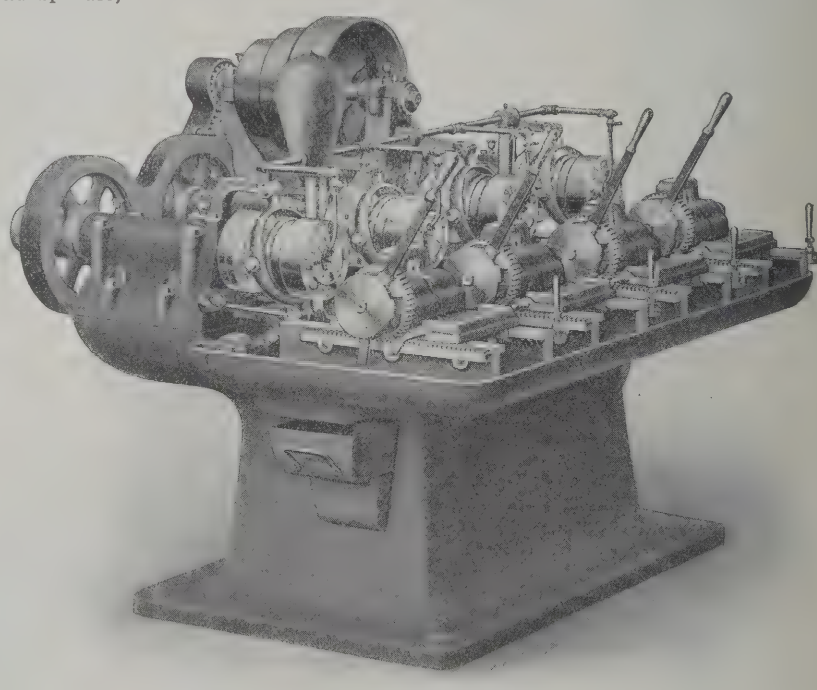
The method employed in testing the accuracy of every tooth in the worm-wheel may be of interest, and is shown in Fig. 8. The master plate is mounted in the spindle. This plate has 40 perfect divisions, and, therefore, makes it possible to test the relative and cumulative error for the individual teeth. The maximum relative error allowed on the master plate itself is 0.0005 inch, and the maximum cumulative error at any point on the master plate is 0.002 inch. The average is less than one-half of this. The master plate is 11 inches in diameter and the worm-wheel for the 10½-inch swing head, 5¼ inches, as already mentioned; hence errors on the master plate are correspondingly reduced on the worm-wheel proper.

The Tail-stock

The tail-stock is of the side center type and is shown in Fig. 9. The center is set into the tail-stock at an angle so that the actual center is within ⅛ inch of the inner side of the tail-stock and within ⅛ inch of the top. This arrangement is of great importance as it provides for clearance for cutters and makes it possible to use much larger cutters on many classes of work than would otherwise be possible. This, again, often effectually increases the output of the machine in such instances. The center, by a special arrangement, as indicated in Fig. 9, is firmly fixed in the tail-stock, and a rapid and easy adjustment is provided. A rack and pinion furnish means by which it can be elevated for milling tapers, after which it can be tilted and clamped in alignment with the work.

NATIONAL QUADRUPLE-SPINDLE BOLT CUTTER

The National Machinery Co., of Tiffin, Ohio, is building the four-spindle bolt cutter illustrated herewith. This is provided with the makers' standard opening die and is built in several different sizes. The convenient design of this machine makes it possible for a workman, where the thread is of reasonable length, to feed all four spindles with as little loss of time as when handling the ordinary single or double spindle bolt cutters. A patented single lever vise and carriage movement is used, which enables him to control the carriage and the gripping of the work with a single lever. This is operated with the left hand, leaving the right hand free for placing and removing the work in the vise. The machine is thus particularly adapted to large lots with comparatively long lengths of thread.



National Quadruple-spindle Bolt Cutter

A combined automatic and hand opening and closing device for each head will be furnished, and these heads can be run independently or in unison. The drive is furnished by a three-step cone pulley, placed on top of the machine. This reduces the floor space, enables the shaft to be supported at both ends, and keeps the belt free from grease and chips. The die heads provided on the machine are self-contained, and do not depend on outside mechanism to control the locked position. This makes the head practically a solid die when closed, insuring accuracy in the product. The makers' interchange-

able case dies are used. The machine has a forced-feed lubricating pump, with adjustable stroke for regulating the flow.

WALKER "SINGLE STROKE" SURFACE GRINDER

The accompanying engravings illustrate a very attractive design of rotary surface grinder of the cup wheel type, made by the Walker Grinder Co., Worcester, Mass. This machine differs from other cup wheel surface grinders in that no reciprocating movement is provided for, the work being mounted on a rotary magnetic chuck, while the wheel is fed straight down against it until it has been finished to the proper thickness. It thus has a large field in the accurate surfacing and sizing of such parts as piston rings, thrust collars, small dies, milling saws and other work of a like nature.

General Design

The general design of the machine comprises a stiff column of vertical form, provided with two vertical slides, the lower of which carries the rotating wheel-spindle, which is adjustable for height to give the desired thickness of work; the upper or wheel-slide carries the wheel-spindle, and is fed down against a positive stop to obtain the proper thickness in the parts being ground. A single pulley drive is employed which provides power for all the movements of the machine, and makes it easily adaptable to motor driving. Two work-spindle speeds are furnished. The single lever which controls

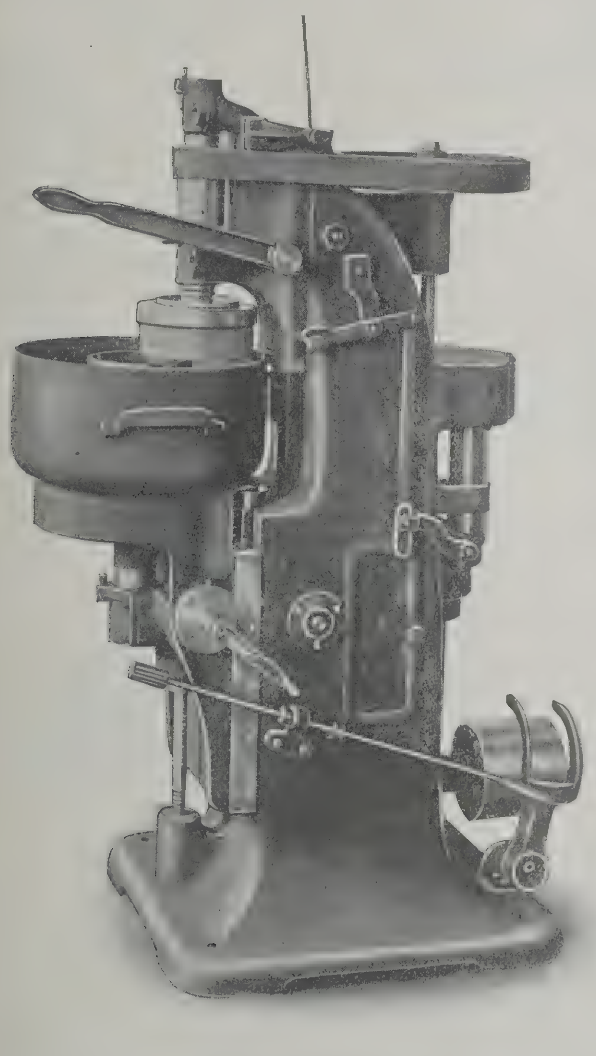


Fig. 1. A Rotary Surface Grinder, provided with Magnetic Chuck

the feeding movement of the wheel-spindle slide also operates to control the starting and stopping of the work-spindle, the switching on or off of the magnetizing current for the chuck, and the control of a demagnetizing current for eliminating the residual magnetism, to permit the work to be removed easily and without scratching. These last features are recent inventions of Mr. Walker, which will be described further on. Their use, in combination with the other improvements furnished, has made possible the rapid manipulation of the machine, and, consequently, gives it a very high output.

The Driving Mechanism

The details of the construction are best shown in Fig. 3, which should be studied in connection with the elevations in Figs. 1 and 2. The tight and loose driving pulleys are shown at *A*. A belt shifter is provided whose handle extends forward to the operator's working position. The pulley *B*, inside

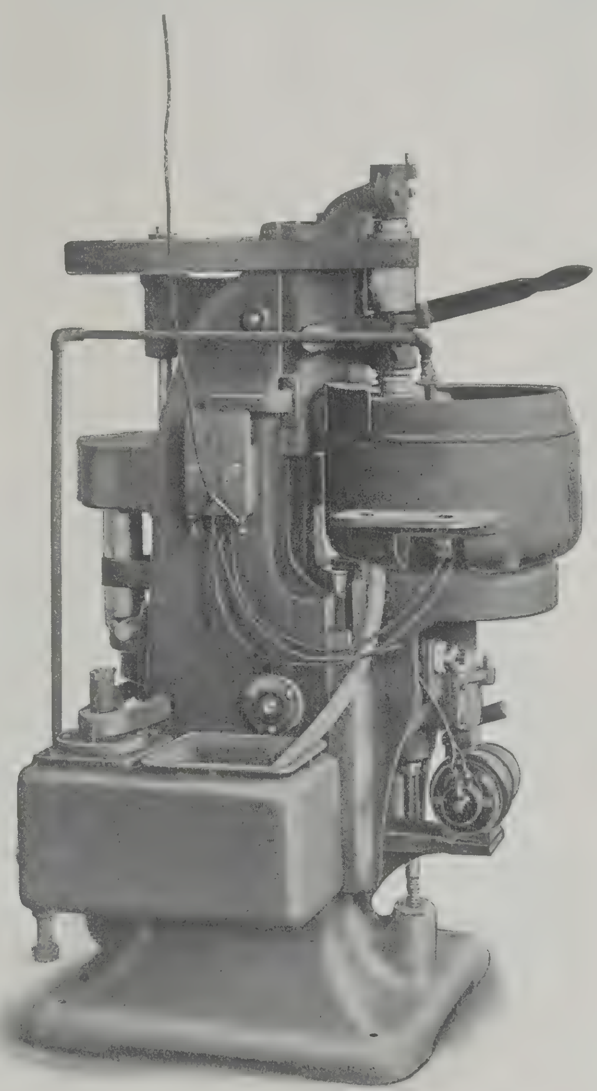


Fig. 2. Machine as arranged for Wet Grinding

the column, is connected by a quarter turn belt with pulley *C* on a vertical driving shaft, the upper end of which carries a large pulley *D*, belted to the driving pulley *E* on the wheel-spindle. The latter has a long enough face to permit the free vertical movement of the wheel-slide *F* by the operation of handle *G*. The wheel-spindle is provided with ball thrust collars on both sides of its lower bearing. Vertical shaft *H* is also connected by gearing at *K*, with drum *J*. This gearing gives a change of speed for the work-spindle. Pulley *L* on the latter is belted to this drum *J* over an idler. *J*, it will be seen, is long enough to permit the vertical adjustment of work-slide *M* throughout its whole range.

The Automatic Control of Work-spindle Drive, Magnetizing Current, etc.

The grinding wheel *N* is brought down to the work and is fed against it by the operation of hand lever *G* and the rack and pinion movement connected therewith. The positive stop which limits this downward movement is shown at *O*. This wheel-slide is counterbalanced by a weight inside the column, as shown, so that when the handle is released it returns to its upper position, leaving plenty of room under the wheel for the easy placing and removal of the work. The link and lever connections shown at *P* connect the wheel-slide *F* with a jaw clutch inside of drum *J*, disconnecting the latter from the shaft on which it is mounted when slide *F* is in the upper

position. By this means the work-spindle is automatically stopped whenever the wheel is raised from the work.

The automatic control of the magnetizing current is effected by a switch mechanism enclosed in the casing shown at the side of the frame in Fig. 1. The wheel-slide carries an arm provided with electrical contacts, which slide over corresponding contacts in the switch box. In the lowermost position, when the wheel is pressed against the work, the direct current is flowing through the chuck. As the wheel is withdrawn, this contact is broken and a new one is made, sending a demagnetizing current through the coils of the chuck. In the final upper position of the slide, the chuck is entirely disconnected from the current, leaving it free for the removal of the work.

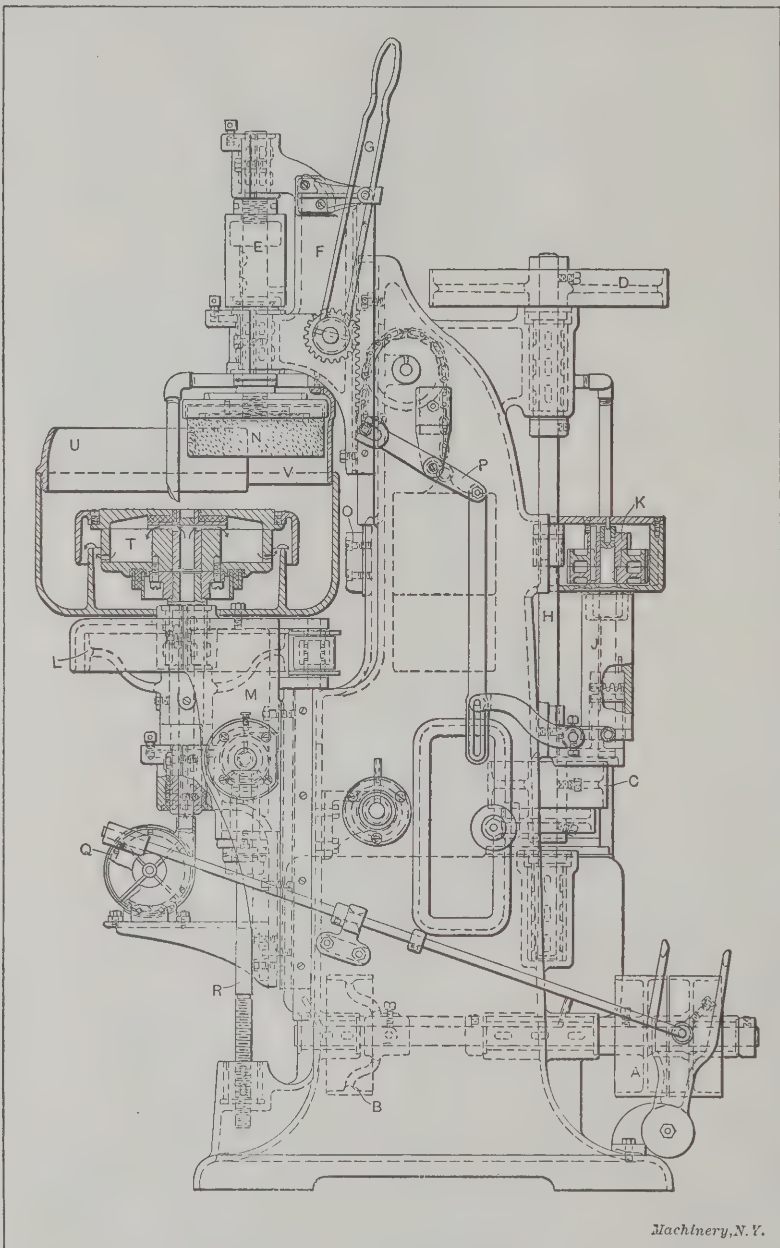


Fig. 3. Details of the Driving and Feeding Mechanism

The Work-spindle and its Slide

As explained, the wheel-spindle slide is brought down each time to a positive stop. The adjustment for thickness of the work is therefore obtained by raising or lowering the work-spindle slide *M*, by means of the crank shown at the side of this slide in Fig. 1 and connected with elevating screw *R* in Fig. 3. When this adjustment is once made, it holds for successive operations, except as it is affected by the wear of the wheel. For this, compensation is made by the gradual raising of the work-spindle slide. The slide is very long in proportion to its overhang, so that there is little elasticity or lost motion.

Special Provisions for Wet Grinding

Fig. 2 shows the machine as arranged for wet grinding, and Fig. 1 for dry grinding. It will be noted that besides the provision of the standard type of centrifugal pump, reservoir and piping, a blower at the lower end of the work-spindle has been furnished. The purpose and construction of this is most plainly shown in Fig. 3, where it is shown at *Q*. It is driven, as shown, by a direct connected motor, and exhausts into the hollow work-spindle, where the current of air is forced through its whole length up into the interior of the chuck, through the magnet coils, and out under the guards into the water space. This current of air effectively prevents moisture from getting into the coils, and thus obviates any difficulty arising from cross-circuits or other electrical troubles, which are otherwise difficult to avoid where a flood of water is employed. Guard *U*, fixed to the lower slide, and *V*, attached to the upper one, keep the water from flying over the machine and operator.

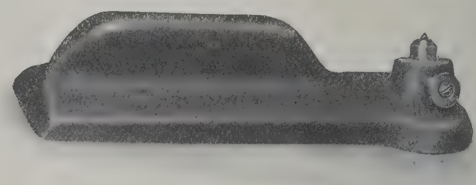


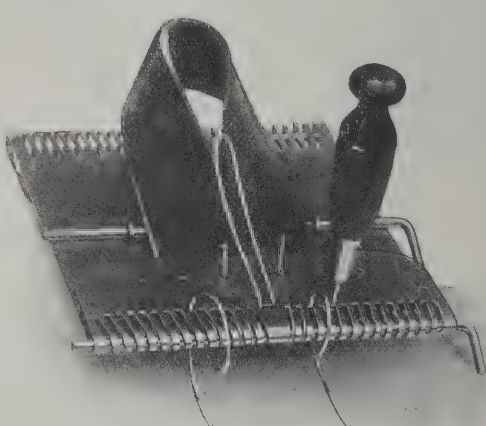
Fig. 4. Tool for Truing, which permits Adjustment of Carbon to present Fresh Cutting Edges

Truing Device for the Wheel

One of the difficulties met with on this style of grinder is the use of the diamond in truing the wheel. The surface of the wheel must obviously be kept true and parallel with the chuck face. To secure this it is necessary that the diamond be mounted in a holder which slides on the chuck face or platen, underneath the wheel. It will be seen that with this arrangement, the wear must necessarily come in one place on the carbon, resulting in a gradual flattening of the cutting edge, and the consequent glazing of the wheel.

Fig. 4 shows an improved carbon truer designed to overcome these objections. In this device the stone is set in a shouldered stem, fitted in the top of a flat holder. This stem is set at a considerable angle from the vertical. With this arrangement, when a flat spot has been worn on the carbon, the stem can be swiveled slightly and fastened in a new position, thus providing a means of obtaining new cutting points on the carbon and a keen cutting surface on the grinding wheel. Means are also provided for disconnecting the automatic switch so that both the magnetizing and the demagnetizing currents are cut off, allowing the free manipulation of the carbon holder when truing the wheel.

The diameter of the wheel is 8 inches, and that of the chuck is 10 inches. By reason of the provision of the magnetic chuck, a large number of small pieces may be held at once, making the machine especially suitable for rapid and accurate manufacturing.



An Inexpensive Outfit for Wire Belt Lacing

MUMFORD WIRE HINGE BELT LACING DEVICE

In the department of New Machinery and Tools of the July, 1909, number of MACHINERY, we illustrated a belt-lacing device made by the Mumford Mfg. and Supply Co., 258 West 22nd St., New York City. This device makes a lacing of the type in which a coil of wire is threaded through each end of the belt. When these coils are interlocked a raw-hide pin is drawn between them, forming the hinged wire belt lacing which has become so largely used on account of its efficiency and durability.

The improvements in the device consist in making provision for both single and double belts and in avoiding the necessity for turning the templet over for lacing the opposite ends of the belt. The way in which these improvements are made will appear from the description. The templet is fastened to the bench in any convenient way. As shown, it is done by staples which project through slots in the plate, and it is locked by a wire rod passing through the staples. The end of the belt is inserted in the turned-up front of the templet, where it is held by lightly driving in one or two wire nails as shown. The slots serve to guide the workman in making the holes with the awl, and in threading the wire through them with a pair of pliers. The wire lacing is threaded over a mandrel placed in the templet in front of the belt as shown.

It will be noted that the slots run right-hand on one side of the center and left-hand on the other. For narrow belts, such as that shown in the engraving, the belt may be doubled back so that both ends are laced at once, one of them right-hand and the other left, allowing the laced ends to interlock properly. Wide belts should be placed in the templet evenly spaced on each side of the center line, so that half of the lacing is right-hand and the other left-hand. When the other end is placed in the similarly laced templet the other side up the two ends will interlock. The original construction provided right-hand slots at one end of the templet and left-hand ones at the other end, necessitating a reversal for each operation. In this improved construction the templet at one end provides for single thickness belts and for double thickness at the other. The slots for the latter are alternately long and short, allowing for staggered lacing.

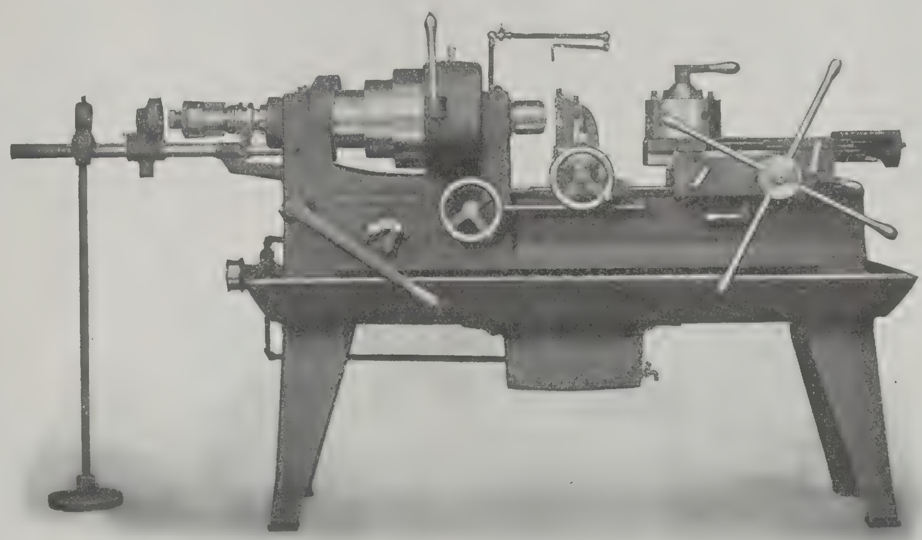
While the device has a width of only 6 inches, it may be used on any width of belt by shifting from one position to another. It is the only tool of its kind which can be used for a belt wider than itself. As previously described, the equipment comprises the templet, the necessary mandrels, an awl, pliers, and a supply of wire and raw-hide pins.

DRESES POWER FEED SCREW MACHINE

The illustration shows a very complete screw machine made by the Dreses Machine Tool Co., Cincinnati, O. This machine is provided with an automatic chuck and wire feed, friction back-gears, positive quick-change feed gearing, power feed for turret slide, separately adjusted automatic stop for each hole in the turret, and fine longitudinal adjustment for cross-slide. The facilities thus provided, in combination with the general excellence of design and workmanship, produce a machine which should be well adapted to a wide range of manufacturing work.

The headstock and bed are cast in one piece, and the design of the headstock provides within itself for the adequate protection of the feed and back-gearing. The spindle is driven by a three-step cone. The frictions for the back gears are of the toggle-joint type, and are so designed that the entire operating mechanism can be put in place or removed without taking out the spindle. These clutches are powerful, easily adjusted and noiseless in operation. The spindle bearings are of the highest grade of babbitt metal, upset into their seats. The nose of the spindle is of an improved construction which provides two blank cylindrical portions each side of the thread, fitting the thimble or faceplate of the chuck. There is no bearing on the thread itself, which merely serves to hold the chuck on and does not in any way affect the alignment. The nose is made very short to bring the work close to the spindle bearing. The thrust is taken up against the inner rear housing of the head, allowing play in the front bearing for the elongation of the spindle from temperature changes. This also reduces the overhang and the length of the front bearing, compared with what would be necessary if the thrust were taken up at that point.

The standard design of chuck and stock-feeding device is used, but special attention has been given to simplifying the operating mechanism, and arranging it for convenient handling. The operating lever, as will be seen, is placed in a position where the workman can exercise the greatest force with the least exertion. The split hub and clamp nut provide for changing the position of this lever to agree with the build or strength of the operator. It will be noted that the thimble for spreading the chuck fingers at the rear end of the spindle is provided with steps, which permit of a considerable variation in the diameter of the stock used without requiring the machine to be stopped for readjustment.



Dreses Screw Machine with Improved Friction Head, Geared Feed and Multiple Stops

The turret has an index ring of as nearly the full diameter as is practicable. A long square gibbed locking bolt holds it firmly into position. By the construction employed, the wearing surface of the turret and slide is not interrupted by the locking bolt, and no particle of metal from the wear of this member in its seat can abrade the surface. Provision is made for taking up the wear of the turret on its stem.

The turret slide is provided with a series of six stops, one for each hole in the turret, mounted on a bracket in the turret slide base. An abutment on the turret slide is provided, which is shifted from one of these stops to the other by a cam placed on the bottom of the turret. This abutment or stop dog makes about one-quarter revolution between the extremes of its movement. By means of an automatic locking plug, it may be instantly put out of action so as to clear all six stops. The bracket in which the stop screws are placed slides in a dove-tail on the turret slide bed. When the stop dog strikes one of the screws, it moves this bracket forward, knocking off the power feed. A slight additional movement can be given it by the pilot wheel for taking a finishing cut on a shoulder, and for cleaning out the chip left by the tool. A geared power feed of four changes is placed in the rear of the bed, and the changes are controlled by the small crank-handle shown beneath the headstock.

The cutting-off rest has a fine longitudinal adjustment on the bed by means of the handwheel, bevel gears and adjust-

ing screw shown. The cross-feed screw is provided with a graduated dial on the handwheel hub. The toolposts are of an improved design. They are open at the left-hand side, permitting them to be adjusted close to the face of the chuck. The wedges under the tools have a single dove-tail to keep them back in position, and knurled thumb-screws are provided for shifting them to adjust the tools to height.

Provision for a large supply of cutting oil or compound is provided by the very deep pan, mounted under the bed of the machine. The oil reservoir is hinged to the pan so that it can be readily cleaned. The inside is provided with two chambers, in the first of which the grit and dirt is separated and deposited before passing into the second or supply chamber, where the pump suction is placed. The leg at the small end of the table is provided with a hinge-joint, so that the machine rests, in effect, on a three-point bearing support, and the alignment is not disturbed by irregularities in the pull.

The tool weighs about 2,600 pounds. It is built in three sizes to take 1, 1½ and 2¼ inches through the wire feed. The illustration shows the 1½-inch machine.

ONEIDA STEEL-REINFORCED INDEPENDENT CHUCK

The line of four-jaw independent chucks made by the Oneida National Chuck Co., of Oneida, N. Y., has recently been greatly improved by an ingenious and inexpensive improvement, the nature of which will be readily understood from an examination of Figs. 1 and 2. This improvement consists in furnishing a steel reinforcement for the cast-iron body of the chuck, so located as to receive the tensile stress imposed by the tightening of the jaws on the work, and at the same time

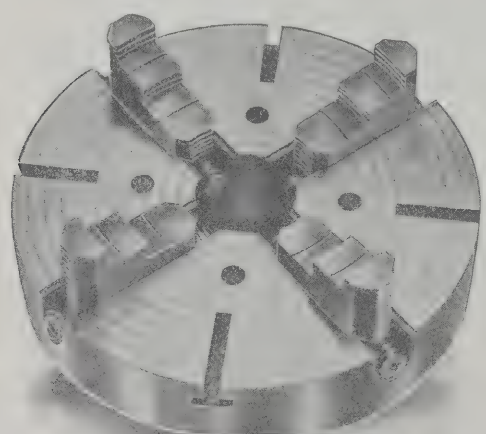


Fig. 1. Independent Chuck, Reinforced for Tensile Strains with a Steel Ring

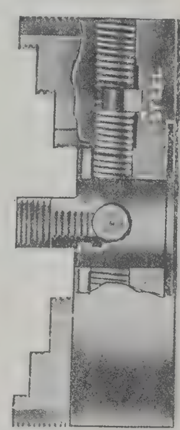


Fig. 2. Showing Steel Ring Cast into Iron Body

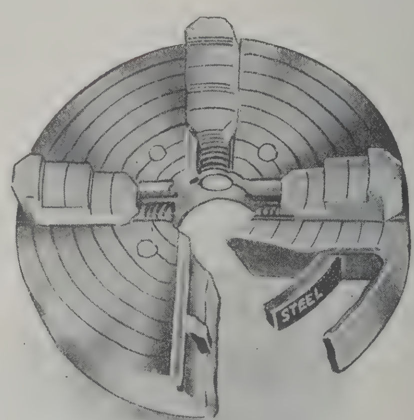


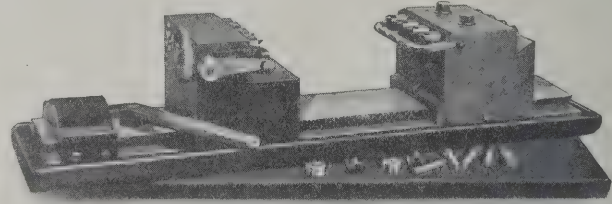
Fig. 3. Showing Location of Reinforcement at Screw Thrust Bearing

furnish a durable steel seat for the thrust bearing of the screws.

The interesting point in this construction is the way in which the steel is located in place in casting. The steel reinforcement is made in the form of an electrically welded ring of bar stock, which is centered in the mold when the chuck body is cast. When the iron is poured it surrounds this steel ring and incorporates it in the casting. Thus no fitting or machining or extra trouble has to be taken at all in the construction. The various machining operations are gone through with as before, and the added expense of the reinforcement is, consequently, negligible. When the chuck is completed, however, the steel bearing surfaces and the steel ring will be found in their proper places to take care of the tensile forces and to furnish the step bearing for the screw.

Fig. 2 best shows the effect of the ring chuck. It ties the body together, as will be seen. All disruptive strain, due to the tightening down of the jaws, is received by the steel in tension, thus relieving and reinforcing the iron, which is notoriously weak for a stress of this kind. Fig. 3 shows most plainly the way in which the thrust bearing is reinforced by the ring, which gives added durability at this point.

The chuck itself is of high-grade construction, with steel operating screws and jaws properly tempered and hardened. The screws, having a center bearing for the end thrust, are threaded to the extreme outer and inner end, giving the jaws the greatest possible capacity for large diameters. Owing to the reinforcement, it is possible to provide a deep seat for the jaws in the body, giving them unusual resisting power to strains tending to overturn them. The enlarged bearing area thus provided also adds very materially to the length of the useful life of the tool.



Four Spindle Index Head Designed for Rapid Manipulation and Convenient Adjustment

Three sizes of this chuck are now in stock, the 10-, 12- and 14-inch, and it is expected to have all sizes ready shortly after February 1. Inasmuch as this improvement is so inexpensive as not to add to the cost of the chuck, its advantages to the purchaser are obvious.

BICKFORD & WASHBURN FOUR-SPINDLE INDEX CENTERS

The tap and reamer fluting device herewith illustrated is made by Bickford & Washburn, 12 Chapman Street, Greenfield, Mass. It is an apparatus of simple construction for a common operation, and is one of a large number of similar devices which have been in use for many years. In spite of the fact that the purpose of the tool is not new, however, we think it will be agreed, after examination, that the designers have succeeded in incorporating a number of new and valuable features in its construction.

The tool comprises a base provided with a dove-tail slide, on which are mounted a tailstock adjustable for height, a headstock carrying the indexing mechanism, and a clamping block and lever for locking the work in place. This base, with the parts mounted thereon, is clamped bodily in place on the table of the milling machine, so that the device is handled as a single unit.

The headstock contains four spindles, connected together by spur gearing so that they are indexed in unison. The front spindle has mounted on it a bevel gear, meshing with a bevel pinion, which latter is provided with a crank and mounted in a bracket attached to the front of the headstock. One revolution of this crank or handle indexes the work between each cut. By changes in the gearing, 3, 4, 5, 6, 7 or 8 cuts may be taken, and a corresponding number of flutes given to the tap

or reamer. The changes in indexing are made by using different bevel pinions to engage with the large bevel gear on the first spindle. One of these pinions is shown in place in the machine and five more are lying on the bench in front of it. The large bevel gear has seventy teeth cut on one side and seventy-two on the other, further extending the range of indexing mentioned. The fact that the index crank is turned exactly one revolution, whatever the number of flutes being cut, is one of the good points of the design, as it makes mistakes in indexing impossible.

The work is held between drivers on the headstock spindles and center points on tailstock spindles. Two forms of these drivers, one for square and the other for round shanks, are shown on the bench in front. The squared ends are driven by the socket shown with square tapered holes, while round work is held and driven by the prong type of driver.

The headstock is a close sliding fit on the dove-tailed base, and it is moved in for clamping, or withdrawn for releasing by the operation of a toggle joint connected with the handle shown. The thrust is taken against the fixed block clamped to the left-hand end of the slide. The tailstock centers are each backed by heavy coiled spring, the strength of whose compression is adjustable by means of the screws and lock nuts shown at the rear of the block. As the headstock is pressed forward by the clamping lever, the blanks are brought up against the spring-supported tail centers to a greater or less degree, depending on the over-all length of the pieces of work. This spring pressure has the advantage over a positive abutment of taking up the looseness which results from the pressing together of the drivers and work at the headstock end under the thrust of the cut. The center points on the tail-stock are easily renewed in case of wear or accident.

Attention should be callea to the means provided for facilitating the removal and insertion of the work. When the headstock is drawn back, the work, while still confined by the drivers at the left-hand end, drops off the tail centers into the notches on the support shown, whence they may be lifted out all together with one hand. In putting the work in the machine this support serves the same purpose, as the blanks are placed in the drivers at one end and dropped into the notches on the support at the other, which brings the center holes at the right height for the tool centers. A single movement of the toggle handle then serves to clamp all four blanks in place.

Another improvement, which will be seen from an examination of the engraving, is the provision of an adjustment for varying the height of the tool centers for cutting taper flutes. This obviates the necessity for blocking up the tail stock on operations of this kind. The tail centers are mounted in a wedge-shaped block which is adjustable on the inclined base provided for it, as shown, thus raising or lowering the tail center points. This gives a vertical adjustment of one inch.

The special advantages of this multiple spindle indexing device may be summed up as follows: First, it provides for great rapidity of action, owing to the use of the support for holding and locating the work before clamping, and the provision of a single movement of the lever for locking four pieces of work in place; second, and perhaps most important, the work when pressed back by the cutter into the driving dogs, is followed up and held fast by extra heavy springs, without the loosening which would result with screw tightened or other positively operated centers; third, taper work is provided for without blocking up. The size shown has a capacity for taps or reamers from ½ to 3 inch.

* * *

The annual reunion of the sales organization of Hill-Clarke & Co., Chicago, Ill., at which were present a large number of the manufacturers whom they represent, was held in the banquet hall of De Jonge's restaurant in Chicago on January 11, and the following evening they attended the theater as guests of the firm.

* * *

"Signs make business. . . . Apart from all business interest a sign on a factory is an ethical courtesy to the traveling public.—*Industrial Department Circular, Erie Railroad.*

NEW MACHINERY AND TOOLS NOTES

Double-end Angle Wrenches in Sets: Frank Mossberg Co., Attleboro, Mass. This firm provides its double-end angle wrenches in sets put up in a neat compartment canvas case, to be used for machine equipment, automobile kits, and standard engineers' and machinists' sets. The wrenches are carefully proportioned and made of a high grade of material. The five wrenches, being double ended, fit ten sizes of bolts and nuts.

Ball Bearing Hanger: Hess-Bright Mfg. Co., Philadelphia, Pa. This firm has devised a special form of hanger particularly adapted to the application of ball bearings to line shaftings. The hanger frame is of box section, and the bearing is provided with adjustments both vertically and horizontally. The design is such as to make the hanger simple in construction and easy to erect and adjust. The line comprises five sizes, practically covering the field for work of this character.

Independent Pump Hydraulic Jack: Duff Mfg. Co., Pittsburg, Pa. This jack, which the makers call the "Duff-Bethlehem," is of the type in which the pump is independent of the ram cylinder, being connected therewith by an 8-foot length of flexible copper tube. This construction permits the use of the jack in confined places and at any convenient angle. It is possible to use one pump for operating several jacks. It may also be employed for general shop work as a small hydraulic press. This apparatus is made in various capacities from 100 to 500 tons, with strokes ranging from 6 to 12 inches.

"Vulcan" Auto Tool: J. H. Williams & Co., Brooklyn, N. Y. This tool is a solid one-piece forging, which combines in itself a remarkable number of functions. It may be used as a hammer, tire lug wrench, cotter pin puller, gas tank wrench, wire insulator scraper, air tank wrench, spark plug wrench, alligator wrench, cotter pin spreader or screw-driver. As a screwdriver it should be particularly effective for confined places, as three blades are provided, set in three different positions. The category of its useful qualities would not be complete without mentioning also the provision of a bottle opener.

"Arpeco" Pipe and Nut Wrenches: Rogers, Printz & Co., Warren, Pa. These wrenches are of unusually simple construction, being formed only of two drop forgings, a drawn steel sleeve of seamless tubing, and a small screw, which serves to hold the parts together. The adjustment consists of the simple sliding of the parts on each other by the fingers of the hand which operates the wrench. A wedge action locks the jaws as soon as the operating pressure is applied. A special thin model is furnished of only ¼-inch thickness for the purpose of getting in small spaces.

Motor-driven Combined Vertical Milling and Slotting Machine: R. M. Clough, Tolland, Conn. This well-known machine is primarily a vertical miller, provided with a simple slotting attachment operated by a worm and worm-gear connection with the milling spindle. It is especially adapted for diemaking and similar work. It has recently been provided with a single motor drive; the connection between the machine and motor is made by a Morse silent chain. A 1½-horsepower, 120-volt Ridgway motor is used for the No. 2 size of machine.

Hydraulic Cold Tire-setting Machine: West Tire Setter Co., Rochester, N. Y. The well-known tire-setting machine made by this firm has recently been adapted to automobile work. When this machine is to be used, the tire is forged large enough so as to be strained beyond the elastic limit when pressing it on the wheel. The forcible compression has been found to densify and improve the metal. A recent machine was provided with 18 hydraulic rams, capable of exerting a pressure of 100 tons each, with a supply pressure of 2,000 pounds per square inch. For an ordinary automobile rim for a 4-inch tire, not more than 15 tons pressure for each ram would be required.

Combined Hand and Power Pipe Machine: Crane Co., Bridgeport, Conn. This machine has a capacity for pipe from ⅛ inch to 2 inches diameter, inclusive, and may be furnished with bolt threading dies as well in sizes ranging from ¼ to ½ inch. The main frame, consisting of the base and bed, is cast in one piece. Compactness for the electric drive is secured by mounting the motor under the rear overhang of the headstock, so that it requires no additional floor space. The action of the motor is by a belt or chain drive. Three speed changes are effected by a geared mechanism, controlled by a single lever. A rotary oil pump is provided for giving continuous lubrication to the dies.

Horizontal Riveting Machine: H. P. Townsend Mfg. Co., Hartford, Conn. The Townsend riveting machine (which was described in a note in the department of New Machinery and Tools in the February, 1909, number of Machinery) is now furnished in horizontal form as well as in the vertical design then described. It is intended for long or bulky work which it is inconvenient to handle in a vertical position. The action of the machine causes a series of disks to strike the end of the riveting hammer, giving a great number of blows per minute, the variation in blows being obtained by variation in speed. The machine will handle rivets from 1/64 up to 5/64 inch in diameter.

MULTIPLE SPINDLE MILLING MACHINE: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This machine was built for special work, but involves a number of new features which might, perhaps, be applied to advantage in a great many general shop operations. The machine is of the planer type, with a horizontal spindle, having a driving head on one column and an outboard support on the other. The cross-rail carries two heads with vertical spindles. These heads are, however, adjustable, so that the spindles may be set at any angle out of the vertical desired, permitting the cutting of angular surfaces with ordinary end and face mills. The machine will mill work up to 16 feet long and 30 inches wide.

COMBINED BENCH CENTER AND CENTERING MACHINE: Artisan School, Syracuse, N. Y. This machine as indicated by its name serves the double purpose of indicating the truth of work mounted on centers and drilling center holes in rough stock with the standard form of combination center drill. The machine is provided with a graduated indicating pointer for showing the amount by which the work runs out of true. An adjustable V-block is provided for supporting work which otherwise would require a "third hand." The rod for knocking out the center drill or center (as may be required) is permanently mounted in the machine. The design of the framework and the general construction of the tool is unique, but of convenient and rational form.

COMBINATION BENCH AND VISE STAND: New Britain Machine Co., New Britain, Conn. This device consists of a 5-inch vise, mounted on a solid iron tripod, either alone or in combination with a tray or bench top. The whole arrangement is compact and occupies a minimum of floor space. It is sold as a unit and is ready for service as soon as it is attached to the floor, on which it rests firmly no matter how uneven it may be. Any make of vise preferred by the customer will be furnished. When one of the swivel base type is used, the binder for locking it operates in a pocket in the front of the tripod rod. When a pipe vise is used, the shelves form a convenient place for dies, cutters or tongues. The size of the table is 20 by 40 inches. The weight complete is 375 pounds.

TAPPING ATTACHMENT FOR SENSITIVE DRILL: Taylor & Fenn Co., Hartford, Conn. We have previously described a number of designs of this make of drill press (see, for instance, the department of New Machinery and Tools in the May, 1909, number of MACHINERY). In this machine the speed changes for the spindle are obtained by a geared change mechanism in the base of the adjustable spindle column. The improved tapping attachment consists of a reversing mechanism, located at the same point and operated by a small projecting lever. The reverse of the spindle is effected by a clutch in combination with a set of bevel gears. The vertical movement of the spindle and its reverse can be controlled by the same hand, though a positive connection between the two movements will be furnished if desired.

ELECTRIC TACHOMETER: Industrial Instrument Co., Foxboro, Mass. This device is essentially an electrical generator, positively connected (by silent chain or otherwise) with the part whose speed is to be measured, and electrically connected with a special volt meter calibrated directly in revolutions per minute. The generator is of the alternating type, so that the uncertain action of brushes and other sliding contacts is avoided. Irregularities in the voltage and consequent vibration of the meter needle are avoided by driving the generator through a fly-wheel, whose connection with the motive power is through a coil spring, which absorbs momentary speed changes. As many indicating dials as may be desired can be attached to a single generator, so that information as to speed may be given in a number of places simultaneously.

INSERTED LATHE TOOL-HOLDERS: G. R. Lang Co., Meadville, Pa. These tools are made in a variety of designs, one of which is particularly interesting in obviating the use of the regulation spherical ring and tilting shoe. The tool is clamped solidly down onto a block on the cross-slide, no adjustment for height of tool being furnished or required, owing to the fact that the point of the tool is ground on the end and not at the top, thus keeping the height constant at the right position. Tools of this design are used for turning, side facing, cutting off, etc. A special cutting-off tool-holder (another new product) permits the use of a blade having flat top and bottom, the proper gripping force being provided without dove-tailing these surfaces as usual. Side clearance is provided so that the blades cut as well as a properly forged tool of the old style.

HAND-FEED AND AUTOMATIC THREAD ROLLING MACHINES: Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. This firm has redesigned its line of reciprocating thread rolling machines, and has introduced a number of improvements. An offset crank is used in place of the former quick return movement for giving a slow, powerful threading stroke. A new device is applied to prevent the possibility, in the automatic feed machines, of getting a blank into the feeding guides in a wrong position, and thus clogging the feed. Extra long dies are used, and provision is made for an extra length of thread as well. The six sizes have a maximum capacity for work from ¼ to 1 inch in diameter, and for a depth of die ranging from 1 to 3 inches. They are built in horizontal form with automatic feed for small and medium work, and hand feed for the heaviest; and in an inclined form for automatically feeding headless blanks. All the mechanism of the machine is thoroughly guarded.

MICRO-ADJUSTABLE BORING HEAD: Porter-Cable Machine Co., Syracuse, N. Y. This tool is intended for use in connection with the maker's sensitive high-speed universal milling attachment, but may be applied to milling machines and drill presses in general. It consists of a shank mounted in the spindle of the machine, carrying a head with cross-slide ways formed in it, on which the tool-holder is adjusted. This adjustment is effected by a micrometer screw with graduations reading to thousandths of an inch. The tool head is provided with a split chuck for holding the cylindrical shanks of the boring tools, and has suitable clamping arrangements for binding it firmly to the tool when the adjustment has been made. The tool itself has a ½-inch shank, and the draw-in chuck furnished is fitted for boring tools of ¼-inch shank. The cross adjustment is ⅜ inch, making it possible to enlarge a hole ¾ inch without change of tool. This device will be found very useful in the accurate boring of small holes in jigs, fixtures, dies, etc.

TELESCOPING INSIDE GAGE: L. S. Starrett Co., Catalogue 18D, Athol, Mass. This gage is intended for use in measuring the exact size of holes or slots by the use of an outside micrometer caliper; the tool is, in fact, a transfer gage, very solid and accurate in construction. In general form it resembles a T-head wrench in which one of the arms of the T telescopes into the other, against spring pressure. After pressing together, it is locked by a thumb-screw at the outer end of the shank and inserted in the hole. Releasing the thumb-screw allows the measuring arm to spring open to the diameter of the hole being measured. Locking the knurled thumb-screw again clamps the arms in this position, after which the tool is removed and the diameter measured. The end of each of the heads is hardened and ground to the radius of the smallest hole the tool enters. The instrument possesses advantages over the inside caliper in the matter of stiffness and accuracy. The gages are made in five sizes, having a range from ½ to 6 inches.

FAN DYNAMOMETER FOR TESTING GASOLINE AND OTHER MOTORS: Joseph Tracy, 116 West 39th St., New York City. We have illustrated various arrangements of fans for absorbing the power when testing engines. These appliances have all been of the home-made order. The above manufacturer has now placed on the market a well-designed and compact apparatus for this purpose which offers several improvements over the home-made construction, the most noticeable of which is the provision of a tachometer directly connected with the spindle so as to give speed readings at all times. The resistance blades on the arms of the fan are radially adjustable to absorb more or less power. For any given position of these blades the tachometer dial may be calibrated to read directly for the power appropriate to a given speed. A series of dials is provided for different positions of the blades, so that the machine will read the power absorption directly over a range running from 1 horsepower at 180 revolutions to 70 horsepower at 980 revolutions.

END MILLS FOR PRECISION WORK: Porter-Cable Machine Co., Syracuse, N. Y. These end mills are built for high-speed operation on fine work, and range in size from 1/16 inch to 5/8 inch in diameter. The mills from 1/16 to 5/32 inch are provided with but a single tooth, which is cut to the center so that the tool may be fed directly into the work like a drill. The sizes from 3/16 to 1/4 inch have two teeth, also cut to the center. All of these mills have straight teeth. For the sizes from 1/4 to 5/8 inch diameter, four or six teeth are used, cut spirally; the larger sizes are made of high-speed steel. The teeth of the mills are given a peculiar form which greatly increases their strength, effecting a large saving in the matter of drill breakages. The unusually small number of teeth used has been found by the makers of exceptionally great advantage. Each tooth has a much stronger backing and is much less liable to break. Their metal-removing capacity is as great as in the older multiple tooth styles, since it has been found that in most cases but one tooth at a time would work anyway. While these tools were designed particularly for the maker's high-speed milling attachment, they are applicable as well to any high-speed milling machine built for accurate work.

AUTOMATIC TEMPERATURE REGULATOR FOR GAS FURNACES: American Gas Furnace Co., 24 John St., New York City. This device is designed to work in connection with a thermo-electric pyrometer, and it is so constructed that the exceedingly delicate movements of the needle of that instrument control a mechanism for opening and closing the gas and air valves without interfering to the slightest degree with the sensitiveness of the operation of the indicating mechanism. It will be admitted that this is something of an achievement in mechanical construction. The power for the valve movements is furnished by a small fan motor connected by a ¼-inch pipe

with the regular air supply of the furnace, so that no special motive power connections are required. The mechanical control of this motor by the needle is effected by a system of interferences, which that needle offers to members driven by the motor. This interference is effected without restraining to the slightest degree the movements of the needle itself. The instrument is designed to hold the temperature control steady within five or ten degrees of a given point of temperature. It may be instantaneously adjusted to any point on the temperature scale, and it is so constructed and enclosed as to be durable and fool-proof.

Engine for Fan and Generating Sets: B. F. Sturtevant Co., Hyde Park, Mass. This firm has for many years built a line of engines for driving either by belt or direct connection the fans and generators which they manufacture. They recently placed on the market a new model of vertical single engine for this work, which incorporates all the improvements which their past experience in this line has suggested. It is of the high-speed, closed type, having openings fitted with dust-proof covers which can be easily removed. A distance piece is provided between the cylinder and the frame which permits access to the stuffing box, and provides, as well, a watershed for keeping the oil from the frame out of the cylinder, and for keeping the water of condensation from the cylinder out of the frame. An oil reservoir is mounted on the frame, from which the oil flows to all the bearings, through piping equipped with sight feed regulators. A reservoir cast in the base receives the oil, where it is filtered through a fine screen and then pumped back to the reservoir. The pump may be dispensed with by keeping the reservoir at the top full, drawing off the excess from the bottom. The Rites inertia governor is used, and provides for a maximum variation of speed between no load and full load of not more than 1½ per cent. For direct connection with a pump, fan or similar apparatus, the base is extended so as to make the whole installation a complete unit. These engines are carefully tested before leaving the works. Particular stress is laid on compactness, economy, dependability and smooth running features, making the engines particularly adapted to isolated electric plants.

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WAGE RAISE RECOMMENDED BY N. M. T. A

Commissioner Robert Wuest, of Cleveland, Ohio, in his monthly letter for January to the members of the National Metal Trades Association, recommends that the members raise wages of their employes wherever possible to keep pace with the great increased cost of living. He says in part:

"To increase wages as the demand for labor increases is good business. That it is doubly good business when an era of great prosperity is at hand cannot be denied. Let us see what would follow this increase of wages of our employes: First, it will keep them in their shops instead of driving them into other shops; second, it will keep them contented and ready to work with hearty good will; third, it will keep our products up to the standard of practice of the times because it will enable us to retain efficient workmen.

"Speaking generally, it is fair to say that the wise policy of manufacturers is to pay their employes the best wages that they can afford to pay. Voicing the sentiment which pervades the councils of the National Metal Trades Association, we wish to impress upon our members the importance of remembering this. The more it is remembered and practiced, the longer we will be immune from strikes and their consequences.

"The papers of the country at this time are full of talk about the increased cost of living. The reasons assigned for this increase are many and varied. . . . But be the reasons what they may, the fact is undeniable that a dollar does not go nearly so far to-day as four or five years ago. It would seem to be good business for all our members to take to heart the foregoing on the wage question. Good wages, the proper education of employes—especially apprentices—the adoption of practical and equitable profit-sharing systems are important factors in the solution of the labor problem."

* * *

TENTH INTERNATIONAL AUTOMOBILE SHOW

The Tenth International Automobile Show was held in the Grand Central Palace, New York City, December 31, 1909, to January 7, 1910, under the management of the American Motor Car Manufacturers' Association. There were over eighty exhibitors of vehicles, and a great number of exhibitors of accessories, the exhibition being distributed over the main floor and the two balconies. The American Motor Car Manufacturers' Association numbers forty-three members, and it is of some interest to note the principal features of the cars brought out by the members of the association. In all, there are 183 different pleasure cars and 86 commercial vehicles made by the members of the association and specified as 1910 models. Of the pleasure cars, only 6 are one-cylinder cars, 14 are two-cylinder cars, one is a two-cycle three-cylinder car, 19 are six-cylinder cars, and the remaining 143 are four-cylinder cars. Of the commercial vehicles the smaller sizes in general are two-cylinder cars, these numbering 50, while 36 are four-cylinder cars. Of the pleasure vehicles only 12 are specified as air cooled, one is either air- or water-cooled, while 170 are water-cooled. Of the commercial vehicles 4 are air-cooled, 7 are either air- or water-cooled and 75 are water-cooled. As regards the approximate power of the cars, 12 of the pleasure cars are of less than 15 H. P.; 30 are between 20 and 25 H. P.; 38 are of 30 H. P. or thereabouts; 24 of 35 H. P.; 20, 40 H. P.; 14, 45 H. P.; 25, 50 H. P.; and 18, 60 H. P. or more. Of the commercial vehicles, 10 are of 20 H. P. or less; 9 of about 25 H. P.; 29 of about 30 H. P.; 4 between 30 and 50 H. P.; 33, 50 H. P.; and one 60 H. P. As regards price, 27 of the pleasure vehicles are priced at less than $1,000; 29 between $1,500 and $2,000; 45 between $2,000 and $2,500; 29 between $2,500 and $3,000; 24 between $3,000 and $4,000; and 29 at over $4,000. Of the commercial vehicles 11 are specified at a price below $1,000; 10 between $2,000 and $3,000; 9 between $3,000 and $4,000; 17 between $4,000 and $5,000, and 10 above $5,000. The price of a number of commercial vehicles is furnished only on application, so that the figures above do not include the whole list of all makes.

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TENTH A. L. A. M. AUTOMOBILE SHOW

The Tenth National Automobile Show took place under the auspices of the Association of Licensed Automobile Manufacturers at the Madison Square Garden, January 8 to 15. There was a total of 56 exhibitors of complete cars, 21 motor-cycle exhibitors, and 246 exhibitors of accessories and parts. The tremendous growth of the automobile industry in the last few years was plainly in evidence to anyone who has had an opportunity to see the National Automobile Show from year to year. On the main floor and on the elevated platform were placed only gasoline pleasure cars, while electric pleasure vehicles were exhibited in an exhibition floor of their own. The basement was occupied by commercial vehicles and motorcycles, while the concert hall and balconies accommodated the exhibitors of accessories. The Madison Square Garden was exquisitely decorated for the event, it being stated that more than $35,000 was spent on decorations. In all, there were 91 gasoline pleasure cars, 2 steam pleasure cars, 22 gasoline commercial cars, and 23 electric pleasure cars exhibited. Of the gasoline pleasure cars 65 were four-cylinder cars and 26 six-cylinder cars. Of the gasoline commercial cars one was a one-cylinder car, 4 were two-cylinder cars, and 17, four-cylinder cars. All the pleasure cars, with the exception of five, and all the commercial cars, with the exception of six, were water-cooled. As regards the power of the cars 2 of the gasoline pleasure cars were of less than 20 H. P., 29 were between 20 and 30 H. P., 20 were between 30 and 40 H. P., and 20 were between 40 and 50 H. P., while 18 were 50 H. P. and over. The power of two of the gasoline pleasure cars was not specified. Of the commercial cars 5 were under 20 H. P., 10 were between 20 and 40, and 6 were 40 H. P. and over. As regards price, 3 of the exhibited cars were priced at less than $1,000, 10 between $1,000 and $1,500, 12 between $1,500 and $2,000, 7 between $2,000 and $2,500, 10 between $2,500 and $3,000, 27 between $3,000 and $4,000, 31 between $4,000 and $5,000, and 30, $5,000 and over.

* * *

A. L. Pfitzner recently made an exhibition flight at Hammandsport, N. Y., with a monoplane equipped with a new balancing device which, it is claimed, does not infringe upon the Wright patents on the warped plane principle. The Pfitzner device consists of two sliding panels at the outer ends of each wing. These panels are mounted on tracks under the wings, and are controlled by cords leading to the operator's seat. Changing the position of the panels accomplishes the same results in the balancing of the monoplane as warping the wings in the Wright models.

* * *

Don't think you are a machinist until you can take a set of drawings and produce from them what the draftsman wants made.

A METHOD FOR LOCATING THE DECIMAL POINT IN SLIDE RULE CALCULATIONS

CHAS. G. RICHARDSON*

The location of the decimal point in the results of multiplication and division has proven a vexatious problem to most users of the slide rule. The formulas heretofore given have proved cumbersome and confusing; inapplicable, practically, to examples of any length. It is believed, therefore, that the following easily remembered method will commend itself to all interested. Bearing in mind that when the words "left-hand figures" are used, *the number of figures to the left of the decimal point* (or in the integral portion of the number) is meant, there are two short rules which must be thoroughly memorized.

RULE No. 1. *Multiplication.* The left-hand figures in the product equal the sum of the left-hand figures in the factors, *except* that one left-hand figure must be subtracted for each time the slide projects to the right.

RULE No. 2. *Division.* The left-hand figures in the quotient equals the left-hand figures in the dividend minus the left-hand figures in the divisor, *except* that one left-hand figure must be added to those in the dividend for each time the slide projects to the right.

These two rules embody the whole method, and once having been learned, there only remains their application. Note that absolutely no reference is made to slide projections to the left.

The "left-hand figures" would be

3	in	843.210
2	in	41.189
1	in	6.922
0	in	0.632
—1	in	0.028
—2	in	0.003 etc.

The use of the two rules will now be illustrated by examples chosen at random, leading from simple problems to those more complex. The calculations are given in detail, but after a little practice the decimal point can be determined mentally with great rapidity.

(Note: It is understood that the lower scales on the slide rule are used.)

Example: $8 \times 5 = 40$.

The slide does not project to the right, therefore add the left-hand figures of the factors, giving two in the product.

Example: $8 \times 5 \times 12 = 480$.

The slide projects once to the right, therefore add left-hand figures of factors and subtract 1, giving 3 units in product.

Example: $8 \times 5 \times 12 \times 0.16 \times 0.08 = 6.14$.

The slide projects twice to the right, therefore $(1 + 1 + 2 + 0 - 1) - 2 = 1$ left-hand figure in the product.

Example: $128.1 \times 132.16 \times 14 \times 11 \times 0.008 \times 0.61 = 12720$.

The slide projects three times to the right, therefore $(3 + 3 + 2 + 2 - 2 + 0) - 3 = 5$ left-hand figures in the product.

Example: $\dfrac{140}{20} = 7$.

The slide does not project to the right, therefore subtract the divisor's left-hand figures from the dividend's, or $3 - 2 = 1$ figure in the quotient.

Example: $\dfrac{360}{24} = 15$.

The slide projects once to the right, therefore add 1 to the dividend's left-hand figures and then subtract the divisor's, or $(3 + 1) - 2 = 2$ left-hand figures in the quotient.

Example: $\dfrac{3600}{24 \times 12} = 12.5$.

The slide projects twice to the right; therefore $(4 + 2) - (2 + 2) = 2$ left-hand figures in the quotient.

Example: $\dfrac{3600}{24 \times 0.12 \times 0.004 \times 18} = 17360$.

The slide projects three times to the right, or there are $(4 + 3) - (2 + 0 - 2 + 2) = 5$ left-hand figures in the quotient.

In formulas involving a combination of multiplication and division, the value of the method especially asserts itself.

Example: $\dfrac{12 \times 8}{16 \times 2} = 3$.

Alternately dividing and multiplying to save unnecessary settings, gives one projection to the right in *division*, but none in multiplication. Therefore, adding 1 to the dividend's left-hand figures and subtracting the divisor's, we have $(2 + 1 + 1) - (2 + 1) = 1$ left-hand figure in the result.

Example: $\dfrac{16 \times 14 \times 24}{30 \times 72 \times 0.8} = 3.11$.

Here we have one projection to the right in *multiplication*, but none in division and consequently $(2 + 2 + 2 - 1) - (2 + 2 + 0) = 1$ left-hand figure in the result.

As we proceed to longer examples it becomes rather difficult to separate *mentally* the number of projections to the right in multiplication from those in division. Short vertical lines may be used to keep this score, as it might be called, these marks being placed either above or below the division line according to whether the operation is respectively one of multiplication or division. Inasmuch, however, as a projection to the right in multiplication *subtracts* 1 and a projection to the right in division *adds* 1 to the left-hand figures in the dividend, it is unnecessary to score every projection to the right, as such a projection in division often may be immediately balanced by moving the runner to the next number in the dividend. In other words, it is only the *unbalanced* projections to the right which it is necessary to record.

To illustrate:

$$\text{Score}\begin{cases}\text{I} \\ \text{II}\end{cases} \quad \frac{114 \times 232 \times 1.98 \times 0.0006 \times 188}{196 \times 0.064 \times 72 \times 0.12 \times 14 \times 12.6} = 0.309.$$

Taking the solution step by step

$114 \div 196$	......slide is to left	
Multiply by 232	......slide is to left	
Divide by 0.064	......slide is to left	
Multiply by 1.98	......slide is to right	(mark above line)
Divide by 72	......slide is to left	
Multiply by 0.0006	......slide is to left	
Divide by 0.12	......slide is to right	} balance
Multiply by 188	......slide is to right	} balance
Divide by 14	......slide is to right	(mark below line)
Divide by 12.6	......slide is to right	(mark below line)

Now the excess of the lower group of "marks" over the upper is 1, therefore the slide has gone to the right once more in division than in multiplication, and 1 is to be added to the dividend's left-hand figures before subtracting the divisor's, or $(3 + 3 + 1 - 3 + 3 + 1) - (3 - 1 + 2 + 0 + 2 + 2) = 0$.

It makes no difference as to the order in which the problem is solved; the *excess* of one group of projections over the other will be the same. Gratifying "results" will certainly follow a little careful study and practical application of the simple principles enumerated.

* Address: Builders' Iron Foundry, Providence, R. I.

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A new 14-inch gun for battleships is being constructed at the Washington Navy Yard. This gun will have an extreme range of 25 miles, although the range at which it will be fired in regular action will be about 5 miles. The projectile from this new gun leaves the muzzle at the velocity of 2,000 feet per second, and when fired with a full charge of 365 pounds of powder it will penetrate 22.7 inches of Krupp steel armor plate, when leaving the muzzle. The projectile weighs 1,400 pounds and the total length of the gun is 53½ feet.

* * *

A prize of 50,000 francs has been offered by the Turin (Italy) Chamber of Commerce, in connection with the Turin Exposition of 1911, for that invention or discovery, made before 1908, that has proved in practice of the greatest advantage in promoting national economy. Applications are to be made, in Italian or French, before April 1, 1911, to "Commissione per il Concorso a Premis, Camera di Commercio, Torino, Italia."

NEW SHOPS AT PURDUE UNIVERSITY

The new buildings which are now under way for the Department of Practical Mechanics at Purdue University, Lafayette, Ind., are worthy of notice as representing a notable advance in the efficiency of practical instruction at that institution.

The organization of this branch of work at Purdue is somewhat different from that in most other technical schools. The department of Practical Mechanics stands by itself, independent of the School of Mechanical Engineering and bearing to the latter somewhat the same relation as do the departments of Mathematics or Applied Mechanics. The department is in charge of a staff of professors and instructors and covers the work done in elementary mechanical drawing, descriptive geometry and shop instruction.

In 1909 the State Legislature recognized the crowded condition of the present shops and drawing rooms and appropriated the sum of $170,000 for new buildings and equipment. Plans and specifications were prepared, contracts let and in May of that year work was begun on the new plant.

As may be seen from the outline plan, the buildings form a connected group containing a front or main building, a longitudinal corridor and transverse wings. The general construction is of the factory type with concrete foundations, brick walls and roofs lighted from above. The main building, 65 by 120 feet, three stories high, furnishes accommodations for class-room instruction and for drawing. On the ground floor are offices, class-rooms and a lecture room 50 by 65 feet. The second and third floors each contain two large drawing rooms and the necessary offices, blue-print rooms, etc.

The remaining buildings are one story in height. A long corridor joining the shops proper has in the basement the heating plant and space for lockers and wash-rooms, while its ground floor contains offices and cases for exhibits and models. The wood shop, 60 by 142 feet, and the foundry, 50 by 104 feet, each under a separate roof, form one wing with an intermediate space of 25 feet used for tools, stock and demonstration rooms. Each building is lighted from overhead as well as from the sides and is capable of indefinite extension in the rear. A basement under the wood shop accommodates stored lumber and contains the shafting and motors for driving the machinery on the main floor. A similar group on the south side contains the machine shop, the foundry and the connecting store rooms and demonstration rooms. The basement of the machine shop will be used for storage.

The buildings will be lighted throughout by electricity and heated by a combined radiation and blower system, insuring uniform temperature and thorough ventilation. The machinery in the shops will be driven by electric motors, both group and independent drives being employed. Alternating and direct currents will be available for the two classes of transmission used.

Plan of New Shops for Department of Practical Mechanics Purdue University

We are indebted to Prof. Charles H. Benjamin, dean of the Schools of Engineering and Director of the Engineering Laboratory for the foregoing information.

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LUBRICATION AND LUBRICANTS

At the regular monthly meeting of the American Society of Mechanical Engineers, January 11, papers on the subject of lubrication and lubricants were read and discussed. The authors of the papers were Dr. Charles F. Mabery, professor of chemistry at the Case School of Applied Science, of Cleveland, Ohio; Prof. F. H. Sibley, of the University of Alabama, and Dr. P. H. Conradson, of the Galena Signal Oil Co.

Dr. Mabery's paper dealt especially with laboratory tests of lubricants containing deflocculated graphite, but contained also considerable matter of direct practical application. The various fields of usefulness of different lubricants were referred to. Greases compounded with graphite, for example, are of particular advantage on low-speed bearings, under heavy load, while natural graphite serves an excellent purpose in cast iron bearings, where it appears to smooth the surface of the porous metal. On close grained surfaces highly finished, however, care must be exercised so that it does not collect and scratch and abrade the journals and bearing.

Some of the tests on the deflocculated graphite gave very interesting results. It was found that a very small amount of graphite suspended in water serves its purpose as an efficient lubricant. For example, an amount of only 0.35 per cent of graphite in water will sustain a pressure of 70 pounds per square inch in the bearing, and a larger amount than that is superfluous. Experiments were also carried out with graphite deflocculated in kerosene and various lubricating oils. It was found that one cubic inch of graphite in three gallons of oil is sufficient to give excellent results and materially reduce friction. Experiments were also undertaken with a view to determine the rise in temperature with the various lubricants, and the most remarkable result in this direction was that graphite suspended in water is an excellent lubrication means for keeping the temperature of the bearings constant. The increase in temperature when testing with this lubricant did not exceed 5 degrees F.

Prof. Sibley's paper described experiments undertaken to determine the relation between viscosity and the wearing and lubricating qualities of oils, and the effect of the constituents of various oils on the lubricating qualities. Twenty-two oils were tested, the method of procedure being to find the chemical composition and viscosity of each oil, and then use it as a lubricant in a journal bearing. The viscosity of an oil is measured by its resistance to flow, a strong resistance to flow indicating a high viscosity. The experiments showed that the viscosity of an oil affects its lubricating quality in the following way: If the oil is adapted to the load put upon it, then the lower the viscosity the better the oil as a lubricant. The oil, however, must conform to the character of the load, a light oil being unsuitable for heavy loads.

While the two previous papers dealt particularly with laboratory tests of oils, Dr. Conradson's paper dealt more directly with practical conditions, and oils suitable for steam turbine plant lubrication, railroad journal lubrication, etc., were discussed by him, as well as several other practical considerations affecting lubricants.

In the discussion following the reading of the papers, Mr. Henry Souther made some interesting remarks relating to the lubrication of automobile cylinders. He had found by practical experiments that a high flash-point oil is not desirable, because of the gum and residue that always results from oils of this kind. These oils give good lubrication while running, but make it difficult to start the engine after it has been standing. The most desirable lubricant for an automobile cylinder is an oil which will take care of the main shaft bearing and the main pin bearings of the piston, and then passing up the piston into the explosion chamber, will disappear as much as possible, so as not to leave any considerable amount of residue oil. Such oils have viscosity of 40 to 50 seconds at 210 degrees F., as measured by the Saybolt viscosimeter, and a specific gravity of from 28 to 31 Beaume.

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PERSONALS

The present address of P. L. Joselevitsch, formerly of 733 E. 16th St., Minneapolis, Minn., is desired by the editor.

W. B. Engler, formerly assistant chief engineer of the Reliance Motor Truck Co., Owosso, Mich., has now been made superintendent of that company.

John J. Grant has been made consulting engineer of all the constituent plants of the Everitt-Metzger-Flanders Co., automobile builders, Detroit, Mich.

Oscar Stegeman has associated himself with Messrs. Landau & Golden, consulting engineers, New York, as a western engineer. He will be located in Milwaukee, Wis.

George H. Hall was recently transferred from the Boston office of the Sprague Electric Co. to its motor and generator department in the company's general office, New York City.

John J. Murphy, blacksmith foreman for the Wabash R. R. at Moberly, Mo., has been appointed to a similar position at Decatur, Ill., succeeding Christopher Jackson, resigned.

Joseph J. Reid has taken charge of the eastern sales department of the Harris Automatic Press Co., with the title of eastern manager. He succeeds E. E. Barney, resigned.

Christopher Jackson, blacksmith foreman at the Wabash Car Shops, Decatur, Ill., left January 1 for Dayton, Ohio, to become superintendent of forges for the Barney & Smith Car Co.

H. C. Fay, of the engineering department of the Remington Arms Co., Ilion, N. Y., has been appointed foreman of the chucking and punch press department to succeed W. H. Dotzauer, resigned.

W. J. Greer, better known as "Genial Jack" Greer, is back again among his own in Pittsburg representing the interests of the Van Dorn Electric and Mfg. Co., maker of electric drills and reamers.

C. E. Chambers has been appointed superintendent of motive power of the Central Railroad of New Jersey, with office at Jersey City, N. J. Mr. Chambers succeeds Mr. William McIntosh, who was superintendent of motive power for many years.

Cyrus F. Raymond, organizing engineer and industrial expert recently employed by the Warner & Swasey Co., Cleveland, Ohio, and later by the Coe Mfg. Co., Painesville, Ohio, has been made superintendent of the Davis-Bournonville Co., New York.

George S. Brown has resigned the position of foreman of the screw department of J. Stevens Arms and Tool Co., to take the management of the Mellor Mfg. Co., Springfield, Mass., a recently established plant for making screw machine products.

Paul Stoner has joined the selling force of the American Emery Wheel Works, Providence, R. I. Mr. Stoner was connected with the Landis Tool Co. for several years, and later with the Allis-Chalmers Co. and the Cleveland Automatic Machine Co.

W. R. Lathrop, who for several years has been connected with the Niles-Bement-Pond Co.'s New York and Birmingham office, has severed his connection and has associated himself with M. E. Dewstoe of Birmingham, Ala., forming the Dewstoe-Lathrop Machinery Co.

George W. Johnson, who lately resigned the superintendency of the Chapman Valve Mfg. Co., Springfield, Mass, has established the Springfield Equipment Co. to do a general mill and factory supply business. He will locally represent the Heller Bros. Steel Co., Newark, N. J.

P. J. Illing, manager of Ludw. Loewe & Co.'s commercial department, sailed for New York the latter part of January on the *Kaiser Wilhelm der Grosse*. He intends to visit the principal machinery manufacturing plants with the object of renewing and opening business connections.

W. H. Dotzauer, foreman of the chucking and punch press department of the Remington Arms Co., Ilion, N. Y., and who has also held the position of foreman in several other departments for the last fifteen years, has resigned to take the position of superintendent of the automobile hub department of the Weston-Mott Co., Flint, Mich.

H. E. Frentzel, for many years superintendent of the shops of Pawling & Harnischfeger, Milwaukee, Wis., retired January 1. He was succeeded by Otto A. Ruemelin, for several years past assistant superintendent. Mr. Frentzel was presented with a handsome silver service by his associates in the shop and office as a mark of their friendship and esteem.

W. R. Wilson, formerly general superintendent of the Columbus Brass Co. and the Columbus Iron Fittings Co., Columbus, Ohio, is now general manager and receiver for the Standish Machine & Supply Co., of that city, manufacturer of the Robinson right angle drive. Under Mr. Wilson's efficient management it is expected that the company will soon be in first-class shape.

J. D. Cox has been elected president of the Cleveland Twist Drill Co., Cleveland, Ohio, to succeed Mr. F. F. Prentiss, who resigned on account of ill health. Mr. Cox is the founder of the business, and has always been the practical man of the concern. He has probably had more experience and been closer in touch with the manufacture of twist drills than any other man now living.

F. A. Hall, who for the past twelve years was manager of the chain block and hoist department of the Yale & Towne Mfg. Co., New York and Hartford, has resigned to take the position of vice-president and treasurer of the Cameron Engineering Co., Brooklyn, New York. Mr. Hall is succeeded by R. T. Hodgkins, who for several years was his chief assistant and who is thoroughly qualified by experience and ability to fill the position.

Henry J. Smith has been promoted from the position of assistant foreman to the foremanship of the Water Shops of the United States Armory at Springfield, Mass. Mr. Smith was promoted from machinist to assistant foreman in 1898. The position of assistant foreman in the Water Shops is practically the same as that of foreman in civilian shops, the term being applied to the heads of departments such as milling, drilling, drop forging, etc.

J. W. Coyle, who was connected with the W. N. Best American Calorific Co. until its retirement from business, is now with the Rockwell Furnace Co., New York, and is giving special attention to oil and gas furnaces for railroad work. Mr. Coyle is an experienced railroad man, having formerly been master blacksmith for the Lehigh Valley R. R. at Wilkes-barre, and later was in charge of the drop hammer and machine department at the forge shops of the Philadelphia & Reading Ry., Reading, Pa.

George Walworth Hayden has been appointed general plant manager of the works of the Pratt & Cady Co. at Hartford, Conn. Mr. Hayden was for nineteen years with the Crane Co. of Chicago working in all departments and rising to be general manager of all its factories, having been chief draftsman, foreman, superintendent and general manager of all the brass, malleable and cast iron departments. He was also in the employ of the United States Steel Corporation and of the McNab & Harlan Co. as works manager at Newark, N. J.

C. H. Ladd has retired from the position of foreman of the Water Shops of the United States Armory at Springfield, Mass., after serving in that capacity for seventeen years. Previous to going to the Water Shops Mr. Ladd was at the Smith & Wesson revolver factory for fourteen years holding the position of foreman and superintendent. He is a Civil War veteran. In civilian shops the position he filled would be called superintendent. He had about five hundred men under him in several departments, including tool-making, hand, drop and rolled forging, milling, drilling, rifling, etc.

At a meeting of the board of directors of the Pennsylvania R. R., January 12, F. E. Abercrombie, superintendent of the New York division, C. F. Dabney, superintendent of the Central division, and W. A. Bannard, superintendent of the Maryland division, were delegated to the general manager's office at Philadelphia to assist in exhaustive investigations of various transportation problems. These men, who are to be known as special agents on the staff of the general manager, are well fitted for their duties on account of long experience in the operating department, especially divisional work, of the railroad.

Charles Kirchhoff, who recently retired from the editorship of the *Iron Age*, was given a tribute of regard in a luncheon at the Engineers' Club, New York, January 16, just prior to sailing on a cruise to the West Indies. The luncheon was attended by about 120 manufacturers, professors, editors, chemists, etc., prominent in the business world and their professions. Letters of regret were read from Andrew Carnegie, Ambrose Swasey, John Hayes Hammond, H. G. Prout, Prof. Henry M. Howe and others. Mr. Kirchhoff was presented with a bronze statue by Picault entitled "La Source du Pactole," by his colleagues on the *Iron Age*, as an evidence of regard and admiration. Mr. George W. Cope, who made the presentation, said in part referring to the gift: "It is emblematical of your profession as well as of the cause in which you have so long employed your energies and your talents. The engineer holding in one hand the dividers and in the other a hammer, contemplates the Pactolian stream, and as he muses we can well believe that he exults in the thought that his labor is also productive of wealth. How much and how effectively your labors have contributed to the material benefit of those who have for years used the *Iron Age* as an important factor in the conduct of their business is beyond my power to estimate."

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OBITUARIES

Samuel E. Riendeau, assistant foreman of the screw department of the J. Stevens Arms and Tool Co., Chicopee Falls, Mass., died at his home December 21, aged thirty-eight years.

George S. Taylor, treasurer of the Belcher & Taylor Agricultural Tool Co., Chicopee Falls, Mass., since its incorporation in 1864, died of pneumonia at his home in Chicopee Falls, Mass., January 3, after an illness of four days, aged eighty-eight.

William Baxter, Jr., died at his home in Jersey City, January 12, after a brief illness with pneumonia, aged fifty-six years. He was born in Troy, N. Y., and was given an academic education. He acquired considerable valuable experience in designing steam and hydraulic machinery between 1860 and 1880 with his father, William Baxter, Sr., who was a well-known builder of engines and machinery and an inventor of considerable reputation. William Baxter, Jr., inherited the inventiveness of his father and made several inventions of merit in electrical apparatus, elevators, etc. He entered the electrical engineering field in the early eighties and afterwards devoted himself largely to this work and elevator improvements. He was a pioneer motor inventor and manufacturer. He invented the first enclosed arc lamp about 1882. He put stationary motors on the market in 1886 and railway motors in 1890. He was the first to design and place on the market the single reduction type of railway motors now universally used on trolley cars. Previous to Mr. Baxter's improvement, motors were double reduction with intermediate shaft between the motors and car axle. This arrangement was used to obtain sufficient power to operate the car without making the motor too heavy. Since 1895 Mr. Baxter had acted as a consulting engineer and writer. He wrote extensively for various mechanical and electrical journals on nearly all the industrial applications of electricity, and on elevators of all kinds. His series, "Electrical Railway Machinery and Apparatus," recently published in the railway edition of MACHINERY, is a case in point.

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Don't grind a lot of clearance on one side and no clearance on the other side of a thread tool.

COMING EVENTS

April 13-14.—Annual convention of the National Metal Trades Association at the Hotel Astor, New York. Robert Wuest, commissioner, 605 New England Building, Cleveland, Ohio.

April 17-June 1 (April 4 to May 19, O. S.).—International exhibition of internal combustion motors under the auspices of the Imperial Russian Technical Society of St. Petersburg on the premises of the society Panteleimonskaia No. 2. The object of the exhibition is to acquaint the consumer as well as the general public at large with the development and present condition of internal combustion motors, and to show the comparative advantages of each of the existing systems. The exhibit will be divided into sections as follows: Motors for agricultural purposes, motors for artisan in small industries, and domestic use, motors for factories, motors for marine, railway, tram-car, automobile, aeronautical and similar purposes, motor details and accessories, literature on motors, drawings, diagrams, etc.

May 4-5.—Annual meeting of the Iron and Steel Institute at the Institution of Civil Engineers, London. G. C. Lloyd, secretary, 28 Victoria St., London.

May 31-June 3.—Spring meeting of the American Society of Mechanical Engineers, Atlantic City, N. J.

June 1-August 31.—American Exposition in Berlin, under illustrious auspices, to stimulate trade relations between Germany and America. This will be the first all-American exposition ever held in a foreign country and will be of interest to all Europe as well as America. It will be held during three of the best months of the year for an exposition, being at the full tide of the foreign travel, when people will be attracted in large numbers. Max Vieweger, American Manager, 50 Church St., New York.

June 6-10.—Convention and exhibition of the Foundry & Manufacturers' Supply Association, Detroit, Mich., C. E. Hoyt, secretary, Lewis Institute, Chicago, Ill. Cadillac Hotel, Detroit, headquarters of the association convention week.

June 7-9.—Convention of the American Foundrymen's Association and American Brass Founders' Association, Detroit, Mich. Headquarters, Hotel Ponchartrain. Richard Moldenke, secretary. American Foundrymen's Association, Watchung, N. J. W. M. Corse, secretary. American Brass Founders' Association.

June 13-16.—National Gas and Gasoline Engine Trades Association convention at Cincinnati, Ohio, Hotel Sinton, headquarters. Albert Stritmatter, secretary.

June 23-28.—International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology at Dusseldorf, Germany. For information apply to G. C. Lloyd, 28 Victoria St., London.

July 26-29.—Joint meeting of the American Society of Mechanical Engineers and the British Institute of Mechanical Engineers in Birmingham and London, England.

SOCIETIES AND COLLEGES

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS, organized in 1901, elected the following new officers at the last annual meeting at Lima, Ohio, November 19-20: president, O. F. Rabbe, Toledo, Ohio; vice-president, Grant Miller, Toledo, Ohio; secretary and treasurer, Prof. F. E. Sanborn, Columbus, Ohio; managers, Ira Cole, Lima, Ohio, C. F. Baker, Covington, Ky., E. M. Adams, Akron, Ohio.

SOCIETY OF ENGINEERS, 17 Victoria St., Westminster, S. W. England will award a status prize each year for the next four years ending 1913 for the best paper written by any person on the subject "How to Improve the Status of Engineers and Engineering with Special Reference to the Consulting Engineer." The prize will be books or instruments or both to the value of three guineas selected by the author of the winning essay. Essays should be written in the third person and should contain not fewer than 4,000, or more than 6,000, words.

STEVENS ENGINEERING SOCIETY, Hoboken, N. J. Program of lectures for the season 1909-10. The society is affiliated with the American Society of Mechanical Engineers. The speakers yet to appear are Samuel Whinery, February 8, subject, "Pavements for City Streets;" David S. Jacobus, February 15, subject, "Power Plant Economics;" Henry L. Gantt, February 21, subject, "The Engineer as a Manager;" John F. O'Rourke, March 1, subject, to be announced; Hermann F. Cuntz, March 8, subject, "Automobiles;" William J. Hammer, March 15, subject to be announced; Charles R. Richards, March 22, subject "Art and Industries of the Orient;" George V. Wendell, March 31, subject, "The Gyrostat and its Application;" Lewis A. Martin, April 5, subject, "The Theory of Gyrostatic Motion;" Frank B. Gilbreth, April 12, subject, "Methods and System in Relation to Handling Concrete Work;" John C. Ostrup, April 19, subject, "Notable Examples in Modern Construction;" David Watson Taylor, April 26, subject, "Development of the New Navy;" Charles F. Kroeh, May 3, subject, "Immortality;" John A. Brashear, May 10, subject, "The Contribution of Photography to our Knowledge of the Stellar Universe."

NEW BOOKS AND PAMPHLETS

GOOD ROADS. Bulletin No. 20. 53 pages, 6 x 9 inches. Published by the University of South Carolina, Columbia, South Carolina.

OCCLUDED GASES IN COAL. Bulletin 52. By S. W. Parr and Perry Barker, 28 pages, 6 x 9 inches. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

PROCEEDINGS OF THE FOURTEENTH ANNUAL CONVENTION OF THE NATIONAL ASSOCIATION OF MANUFACTURERS. 270 pages, 6 x 9 inches. Issued from the secretary's office, 170 Broadway, New York.

PROCEEDINGS OF THE SEVENTEENTH ANNUAL CONVENTION OF THE TRAVELING ENGINEERS' ASSOCIATION HELD AT DENVER, COLO., September 7-10. 396 pages, 6 x 9 inches. W. O. Thompson, secretary, Buffalo, New York.

PROCEEDINGS OF THE SEVENTEENTH ANNUAL CONVENTION OF THE INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION AT NIAGARA FALLS, N. Y. August 17-19, 1909, 189 pages, 6 x 9 inches. A. L. Woodworth, secretary, Lima, Ohio.

INDUSTRIAL PEACE AND INDUSTRIAL EFFICIENCY. 30 pages, 5¼ x 8 inches. Published by the Anti-Boycott Association, 27 William St., New York.

This pamphlet is a reprint from an English publication giving the terms of Sir Christopher Furness' co-operative scheme, or "The Treaty of the Hartlepools."

FUEL TESTS WITH HOUSE-HEATING BOILERS. Bulletin No. 31, by J. M. Snodgrass. 108 pages, 6 x 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

The bulletin reports 130 tests of anthracite, Pocahontas, coke and Illinois coal made in connection with two types of house-heating boilers. The efficiency obtained varied from 44 to 66 per cent.

LOCOMOTIVE BREAKDOWNS. By George L. Fowler and William W. Wood. 292 pages, 4¾ x 6½ inches, illustrated. Published by Norman W. Henley & Son, New York. Price $1.00.

This work, which was first published in 1903, has passed into the sixth revised and enlarged edition. It is in catechism style, the questions selected being based on the experience of engineers, air brake inspectors, and others connected with locomotive operation and maintenance. The contents by chapters are: Defective valves; accidents to the valve

motion, Stephenson link gear; accidents to cylinders, steam chests, and pistons; accidents to guides, crossheads, and rods; accidents to the valve motion, Walschaerts radial gear; accidents to running gears; truck and frame accidents; boiler troubles; defective throttle and steam connections; defective draft appliances; injector troubles; accidents to cab fixtures; tender accidents; miscellaneous accidents; accidents to compound locomotives; tools and appliances for making engine repairs; locating and remedying air-brake troubles; the Pyle National electric headlight; rules, tables and other information. The details of the Pyle National electric headlight are illustrated on a folding plate.

Practical Engineer Pocket-book and Diary for 1910. 684 pages, 3½ x 4½ inches, in addition to which are many pages of advertising and blank pages for the diary. Published by the Technical Publishing Co., Ltd., 55-56 Chancery Lane, London, England. Price, leather, 1s. 6d.; cloth, 1s.

A great fund of useful engineering information is contained in the limits of this convenient pocket-book, as is shown by the following partial statement of contents: Standard of weights and measures, areas of small circles advancing by decimals, areas of circles up to six inches diameter advancing by thirty-seconds and sixteenths, areas of circles advancing by tenths from 1 to 100 inclusive, tables of squares, logarithms, chords, wire gage and metric conversion, steam boilers and furnaces, chimneys, boiler fittings, feed water, boiler joints, boiler trials, steam consumption, properties of saturated steam, indicator dimensions, steam engine details, sizes of steam pipes, relative strength of solid and hollow shafts, heating of buildings, condensers, steam engine regulation, springs, beams, steam turbines, gas producers, gas engines, refrigeration, water turbines and Pelton wheels, pumps, gearing, belting, chain driving, rope driving, emery grinding, limit gages, speed of cutting tools, power required for machine tools, pyrometry, cranes, ball bearings, roller bearings, reinforced concrete, strength of materials, etc.

Annual Report of the Smithsonian Institution, 1908. 801 pages. 6 x 9 inches; illustrated. Published by the Smithsonian Institution, Washington, D. C.

This well-known publication contains the report of the Smithsonian Institution and, as has been the custom for some years, a series of valuable technical articles on various phases of scientific development, as follows: "The Present Status of Military Aeronautics," by Major George O. Squier; "Aviation in France in 1908," by Pierre-Roger Jourdain; "Wireless Telephony," by R. A. Fessenden; "Phototelegraphy," Henri Armat; "The Gramophone and the Mechanical Recording and Reproduction of Musical Sounds," by Lovell N. Reddie; "On the Relations Between Matter and Ether," by J. J. Thomson; "Development of General and Physical Chemistry, during the past Forty Years," W. Nernst; "Development of Technological Chemistry during the last Forty Years," by O. N. Witt; "Twenty Years' Progress in Explosives," by Oscar Guttmann; "Recent Researches in the Structure of the Universe," by Prof. Dr. J. C. Kapteyn; "Solar Vortices and Magnetism in Sun Spots," by O. G. Abbott; "Climatic Variations: Their Extent and Causes," by Prof. J. W. Gregory; "Uranium and Geology," by Prof. John Joly; "An Outline Review of the Geology of Peru," by George I. Adams; "Our Present Knowledge of the Earth," by E. Wiechert; "The Antarctic Question—Voyages Since 1898," by J. Machat; "Some Geographical Aspects of the Nile," by Capt. H. G. Lyons; "Heredity, and the Origin of Species," by Daniel T. MacDougal; "Angler Fishes: Their Kinds and Ways," Theodore Gill; "The Birds of India," by Douglas Dewar; "The Evolution of the Elephant," by Richard S. Lull; "Life and Work of Lord Kelvin," by Silvanus P. Thompson, etc.

The Gas Turbine. By Henry Harrison Suplee. 262 pages, 6 x 9 inches. 93 illustrations and diagrams. Published by J. B. Lippincott Co., Philadelphia, Pa. Price, $3.

The intention of the author in publishing this work was to place in the hands of engineers and experimenters such theoretical and practical data as are now available in the solution of the problems of the gas turbine. The historical chapter describes early experiments and illustrates some early forms of gas turbines. Papers read before the Institute of Mechanical Engineers are digested, as well as a paper presented before the Society of Civil Engineers of France. Chapter V discusses the actual behavior of gas engine nozzles, giving account of experiments of Dr. Charles E. Lucke, and describes and illustrates the practical work of Messrs. Rene Armengaud and Charles Lemale. In the last chapter the author draws some general conclusions. So far as predictions may be made, it appears that the most immediate results are to be expected from the so-called "mixed" turbine, that is the type in which the injection of water for cooling purposes causes the machine to partake of the combined nature of the gas and steam turbine. Also, the turbine of the explosive type appears to have arrived at the practical stage already, notwithstanding its low thermal efficiency. Its efficiency, however, is about the same as that of the steam engine of the same capacity. The advantages of the turbine type are so great for certain purposes that Prof. Langley is quoted in speaking of the engine of his flying machine, whereof he said: "It might burn gold, if necessary, so long as it fulfills all the other requirements of the problem." In short, the mechanical advantages of the gas turbine may outweigh its disadvantages, in thermal efficiency and other respects. In this connection it is interesting to note that a new development in gas turbines will soon be announced that will startle the aeronautical world because of the simplicity of the motor and propeller.

Modern Gas Engines, and the Gas Producers. By A. M. Levin. 485 pages, 6 x 9 inches, 100 illustrations. Published by John Wiley & Sons, New York. Price, $4.

The literature on the gas engine is rapidly assuming the importance and profuseness of that on the steam engine. It is fitting that it is so, for the internal combustion engine undoubtedly is the coming motor. It, with the gas producer, will gradually displace the steam engine for the majority of power-producing purposes. The thermal efficiency of the gas engine is higher than that of the steam engine; in certain industries, as the steel manufacture, it offers means of directly converting waste gases into power without the loss and complicated apparatus inseparable from the steam engine. The author in his foreword speaks of the importance of economy in national fuel resources and points to the gas engine as being one means of conserving them. The contents by chapters are as follows: Introduction to Thermodynamics; Design Constants and Formulas; Theoretical Analyses of Gas Engine Cycles; Power, Size and Speed of Gas Engines; Fuels and Combustion; the Proportioning of Mixtures and the Relation of these to the Size of the Engine; Alcohol Fuels: Features of Practical Gas Engine Cycles; the Fly-wheel; the Crankshaft; Engine Details; Governing; Engine Auxiliaries; Various Gas Engine Types; Producer Gas and Gas Producers. The work treats of gas engines with particular reference to the stationary types for general power purposes. While automobile engine design is not neglected, the importance of this specialized type would seem to have merited considerably more attention than the author gave it, especially when it is conceded that the automobile development has had a great improving influence on small internal combustion motor design. Space will not permit of a more detailed reference to the otherwise excellent phases of the work, except to say in conclusion that it is essentially a book for the designing engineer. The treatment of stresses in crankshafts, thermodynamics, etc., should give the average designer bases on which to work in almost all phases of gas engine design.

Gas, Gasoline and Oil Engines. By Gardner D. Hiscox. 476 pages, 6 x 9 inches, 370 illustrations. Published by Norman W. Henley & Son, New York. Price, $2.50.

This book, which was first published in 1897, has passed into the eighteenth edition. It was revised and extended by the author before his death. In the foreword he says that the gasoline engine has almost superseded the windmill for farm and suburban use and many manufacturers are employing it in preference to electricity for portable machines. It is estimated that there are about 10,000 manufacturers of gas, gasoline and oil engines in the United States. The author gives an account of the historical progress of the internal explosive motors, and follows with the theory of gas and gasoline engines, isothermal and adiabatic law, formulas and examples, tables, utilization of heat and its efficiency in explosive motors, temperatures and pressures, formulas and examples, retarded combustion, wall cooling and compression efficiencies, advanced ignition, compression in explosive motors and its work, causes of loss in efficiency in explosive motors, form and influence of combustion chamber, economy of gas engine for electric lighting, merits of the two- and four-cycle type, gas engine fuels, carbureters and vaporizers, cylinder capacity of gas and gasoline engines, governors and valve gear, explosive motor ignition, cylinder lubrication, constructive details and dimensions, measurement of power, gas engine testing, marine gas engines, motor bicycles, producer gas and its product, etc. The automobile and marine types of internal combustion motors are exhaustively treated, a large number of forms and constructions being illustrated and described. This section makes this work particularly acceptable to many designers concerned with the design of small motors. Practical hints on assembly are given in the chapter of construction and details and parts of explosive motors. The well-known method of using strips to set the piston rings when entering the piston into the cylinder, is illustrated and described. The author saw fit to give credit for it to a gas engine designer, but as a matter of fact, this method was in common use long before the engineer named was born. The work as a whole is heartily commended.

CATALOGUES AND CIRCULARS

General Electric Co., Schenectady, N. Y. Circular of tungsten automobile electric lamps.

Warren Webster & Co., Camden, N. J. Booklet on the Webster modulation heating system.

McDowell, Stocker & Co., 121 N. Jefferson St., Chicago, Ill. List of second-hand machine tools.

New York Machinery Exchange, 50 Church St., New York. List of second-hand machine tools.

H. W. Johns-Manville Co., 100 William St., New York. Circular of "Sanitor" closet seats and tanks.

University of Illinois, Urbana, Ill. Circular of information of the Department of Mining Engineering.

Sprague Electric Co., New York. Bulletin No. 110 superseding bulletin No. 107 on Sprague electric generators.

Sargent Steam Meter Co., 271-285 East Madison St., Chicago, Ill. Catalogue of Sargent automatic gas calorimeter.

Cincinnati-Bickford Tool Co., Cincinnati, Ohio. Circular R-50 illustrating and describing the Bickford 2½-, 3- and 3½-foot plain radial drill.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. Handbook and stock list of machines and small tools for the fabrication of iron and steel.

Pawtucket Tool Co., Pawtucket, R. I. Circular of Thompson automatic tapping chuck, which is made in both reversing and non-reversing types.

Hunter Saw & Machine Co., 37th and Butler Sts., Pittsburg, Pa. Circular and price list C of circular metal-cutting saws, saw sharpening machines, etc.

Leiman Bros., 62 John St., New York. Circulars of pressure blowers (see Machinery, January, 1909), sand blast apparatus, melting furnaces, etc.

Western Electric Co., 463 West St., New York. Bulletins No. 5131 and 5132 on motors and generators, type IL, and interpole motors, type ELC.

Eck Dynamo & Motor Co., Belleville, N. J. Circular of Eck motors and dynamos of protected, enclosed, Manchester, back geared, vertical, variable speed and worm gear types.

Howell & Murray, Waverly, N. Y. Circular of the Howell adjustable work clamp for clamping work to lathe faceplates, boring mill tables, planer platens, etc.

Sprague Electric Co., New York. Circular of Sprague "multilets." These junction boxes for electric service are made of stamped steel in two sizes with a set of covers for each size.

Richard W. Jefferis Co., Camden, N. J. Folder illustrating the Jefferis pressed steel lockers, unit construction, for use in armories, gymnasiums, factories, clubs, stores, schools, offices, etc.

Commercial Motor Car Co., Times Building, New York. Circular of commercial motor vehicles of gasoline and electric types for transportation systems, comprising light and heavy express wagons, trucks, etc.

E. C. Bliss Mfg. Co., 91 Sabin St., Providence, R. I. Circular of the Bliss milling attachment for upright drills and drill presses. With this attachment, the ordinary drill can be converted into a vertical milling machine.

Brown & Sharpe Mfg. Co., Providence, R. I. Pamphlet on differential indexing, containing formulas and examples for differential indexing, and tables giving gears and index moves from 2 to 382 divisions, inclusive.

Wheeler Condensing & Engineering Co., Carteret, N. J. Booklet entitled "A Radical Improvement in Jet Condensers," being a reprint of the article published in the *Iron Age* on the improved condenser made by the company.

Naylor Bros., 50 Church St., New York. Price list No. 1 of power transmission apparatus comprising Naylor adjustable ball and socket shaft hangers made with double brace parting hanger, wick oiling and babbitted bearings.

Villinger Mfg. Co., Williamsport, Pa. Circular of the Williamsport 14-inch friction drill with quick-change speed device. The machine will drill to the center of a 14½-inch circle and its spindle is fitted with No. 1 Morse taper.

Western Electric Co., 463 West St., New York. Bulletins Nos. 1001, 1002, and 1105 on magneto non-multiple switch-board with manually restored line signals, magneto multiple switch-board with self-restored line signals, and intercommunicating telephone system, respectively.

Kinkead Mfg. Co., 7 Water St., Boston, Mass. Pamphlet describing the Kinkead method of aligning and leveling shafting, including setting up machinery, countershafts, grading steam and water pipes, and the common method in indoor and outdoor surveying for manufacturing plants of all kinds.

Charles Greiner, New Haven, Conn. Card advertising high-speed elastic blow combined riveting and spinning machine which is especially adapted for the assembly of general hardware, typewriters, etc. The machine strikes 6,000 blows per minute, and is claimed to rivet faster than work can be handled.

Supplement to MACHINERY, February, 1910

Operations for the Article in this number entitled "Machine Shop Practice—The Vernier: Its Principle and Method of Reading"

SHOP OPERATION SHEET NO. 124

22	Pitch Cone Angle	Pitch cone angle equals 45 degrees	$\alpha = 45°$
23	Pitch Cone Radius	Multiply the pitch diameter by 0.707	$C = 0.707D$
24	Face Angle	Subtract the addendum angle from 45°	$\delta = 45° - \theta$
25	Cutting Angle	Subtract the dedendum angle from 45 degrees	$\zeta = 45° - \varphi$
26	Angular Addendum	Multiply the addendum by 0.707	$K = 0.707\ S$
27	Number of Teeth in Equivalent Spur Gear	Multiply the number of teeth by 1.41	$N' = 1.41N$

SHOP OPERATION SHEET NO. 125

SHOP OPERATION SHEET NO. 126

These dimensions are the same f...

	Tooth at Pitch Line	The circular pitch by 2	
9	Pitch Cone Radius	Divide the pitch diameter by twice the sine of the pitch cone angle	$C = \frac{D}{2 \times \sin\alpha}$
10	Addendum at Small End of Tooth	Subtract the width of face from the pitch cone radius, divide the remainder by the pitch cone radius and multiply by the addendum.	$s = S \times \frac{C-F}{C}$
11	Thickness of Tooth at Pitch Line at Small End	Subtract the width of face from the pitch cone radius, divide the remainder by the pitch cone radius and multiply by the thickness of the tooth at the pitch line	$t = T \times \frac{C-F}{C}$
12	Addendum Angle	Divide the addendum by the pitch cone radius to get the tangent	$\tan\theta = \frac{S}{C}$
13	Dedendum Angle	Divide the dedendum by the pitch cone radius to get the tangent	$\tan\varphi = \frac{S+A}{C}$

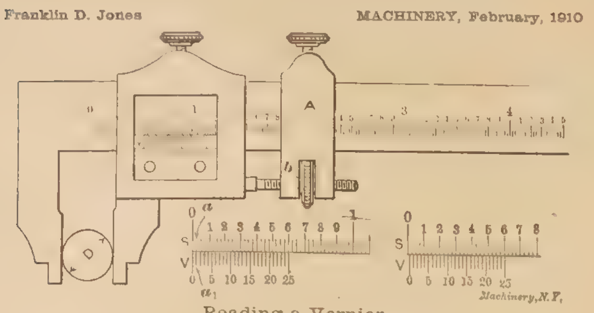
Supplement to MA

Charts for the Article in this nu

Operations for the Article in this number entitled "Machine Shop Practice—The Vernier: Its Principle and Method of Reading"

SHOP OPERATION SHEET NO. 124

Franklin D. Jones MACHINERY, February, 1910



Reading a Vernier

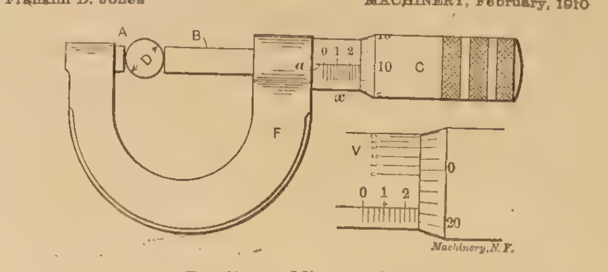
NOTE.—The vernier is an auxiliary scale that is attached to caliper squares, protractors, etc., for obtaining fractional parts of the sub-divisions of the true scale of the instrument. The above illustration shows a caliper square with a vernier scale *V*, reading to 0.001 inch.

1. A section of the true scale, together with the vernier scale, are shown in the enlarged detail views at *S* and *V*, respectively. On this particular instrument, the inch divisions of the regular scale are divided into tenths and each tenth into four parts, so that the finer divisions are fortieths of an inch. The vernier scale *V* has twenty-five divisions, and its total length is equal to twenty-four divisions on the regular scale or twenty-four fortieths of an inch. Therefore each division on the vernier equals 1/25 of 24/40 or 24/1000 inch (0.024). As 1/40 equals 25/1000 it will be seen that the vernier divisions are 1/1000 (0.001) inch shorter than those on the regular scale; so that when the zero marks of both scales coincide, the two first lines a and a_1 to the right, differ by 1/1000 inch; the next two by 2/1000, etc. Now if the zero line on the vernier is moved (as shown in the detail to the right), obviously the distance in thousandths of an inch will be indicated by the number of that line on the vernier that exactly coincides with a graduation line on the scale. In the illustration, it is the tenth line on the vernier that exactly coincides with one on the scale; therefore the distance between the two zero lines is 10/1000 (0.010) inch. If the vernier zero were moved to the right just twice this amount or 20/1000 (0.020) inch, the twentieth division would be exactly in line with one on the regular scale.

2. To measure the exact diameter *D* with a caliper square, adjust the sliding jaw until it is close to the work and then lock the slide *A* by the screw shown. With the nut *b*, which is used for making fine adjustments, move the jaw until it just touches the work. The distance that the vernier scale zero has moved to the right of the zero mark on the true scale (which equals diameter *D*) is then read directly in thousandths of an inch, by calling each tenth on the true scale that has been passed by the vernier zero, one hundred thousandths, and each fortieth twenty-five thousandths, and adding to this number as many thousandths as are indicated by the vernier. The vernier zero in the illustration is slightly beyond the five-tenths division; hence the reading is 0.500 plus the number of thousandths indicated by that line on the vernier that exactly coincides with one on the scale which, in this case, is 15, making the reading $0.500 + 0.015 = 0.515$ inch.

SHOP OPERATION SHEET NO. 125

Franklin D. Jones MACHINERY, February, 1910



Reading a Micrometer

NOTE.—The micrometer caliper is used for taking very accurate measurements. The instrument consists principally of a main frame *F*, a measuring screw or spindle *B* which is threaded into a fixed nut in the frame *F*, and a thimble *C*, which turns with spindle *B*. The pitch of the thread on spindle *B*, and on practically all micrometer screws, is 1/40 of an inch, there being 40 threads on the screw for each inch of its length. Along the frame, as at *x*, there are graduations which are 1/40 inch apart; therefore when thimble *C* and spindle *B* are turned one complete revolution, they move in or out, a distance equal to one of the graduations or 1/40 inch, which equals 25/1000 inch. It is evident then that if instead of turning the thimble one complete revolution, it is turned say 1/25 of a revolution, that the distance between the anvil *A* and the end of spindle *B* will be increased or diminished 1/25 of 25/1000 of an inch. As the beveled edge of thimble *C* is graduated into twenty-five parts, measurements to within one thousandth of an inch are easily taken.

1. To measure the diameter *D* of a piece of work, adjust the spindle *B* until the work will pass between it and the anvil *A*, and then turn thimble *C* until the end of *B* just comes into contact with the work. Next count the number of whole divisions that are visible on the scale *x* of the frame, multiply this number by twenty-five (the number of thousandths of an inch that each division is equal to), and add to the product the number of that division on the thimble that coincides with the line *a*. The result will be the diameter expressed in thousandths of an inch. For example, the diameter indicated by the micrometer when set as shown in the illustration would be determined by multiplying the eleven divisions visible on the frame by twenty-five, and adding ten to the result, that being the graduation number on the thimble that coincides with the line *a*. Then *D* equals $11 \times 25 + 10 = 285/1000$ inch. As the numbers 1, 2, etc., on every fourth graduation, indicate hundreds of thousandths, the reading can be easily taken mentally.

2. By the addition of a vernier scale *V* on the frame (see enlarged detail view), measurements within one ten-thousandth part of an inch can be taken. Micrometers thus equipped are read as follows: First determine the number of thousandths, as with an ordinary micrometer. Next find a line on the vernier scale that exactly coincides with one on the thimble; the number of this line represents the number of ten-thousandths to be added to the number of thousandths obtained by the regular graduations. The reading shown in the illustration is $271/1000 + 3/10000 = 2713/10000$ inch.

SHOP OPERATION SHEET NO. 126

Franklin D. Jones MACHINERY, February, 1910

Reading a Protractor Vernier

NOTE.—A protractor is an instrument that is used for the measurement of angles. The graduations on the protractors commonly used by machinists are ordinarily not finer than whole degrees, so that the instrument cannot be set to, nor measurements taken of, fractional parts of a degree with accuracy. By the addition of a vernier scale, the principle of which was explained on sheet No. 124, subdivisions of a degree are easily read.

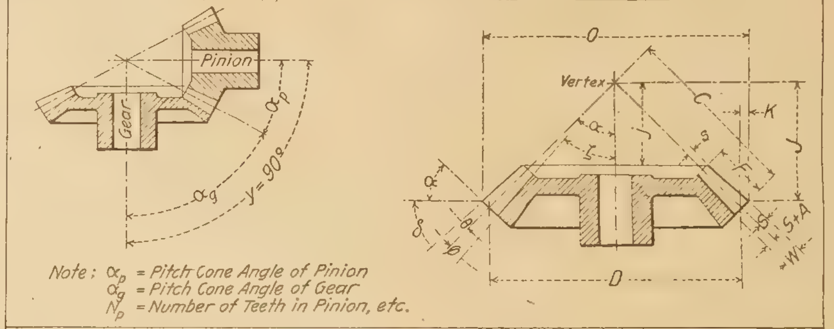
1. The vernier scale *V* of a Brown & Sharpe universal bevel protractor is shown in the illustration above. This particular vernier makes it possible to determine the angle to which the instrument is set within five minutes (5′) or one-twelfth of a degree. The degree, which is the unit of angular measurement—the same as the inch is a unit in linear measurement—is divided into sixty minutes, so that a division of a degree is expressed as so many minutes; thus 5½ degrees equals 5 degrees, 30 minutes (5° 30′). It will be noted that there are practically two scales of twelve divisions each, on either side of the vernier zero mark. The left-hand scale is used when the vernier zero is moved to the left of the zero of the true scale, while the right-hand scale is used when the movement is to the right. The total length of each of these vernier scales is equal to twenty-three degrees on the true scale, and as there are twelve divisions, each division equals 1/12 of 23 or 1 11/12 degree. One degree equals 60 minutes (60′), and 11/12 degree equals 11/12 of 60 or 55 minutes; hence each division on the vernier expressed in minutes equals $60' + 55' = 115$ minutes. Now as there are 120 minutes in 2 degrees, we see that each space on the vernier is 5 minutes shorter than 2 degrees; therefore, when the zero marks on the true and vernier scales are exactly in line, the first two graduations to the right or left are 5 minutes apart; the next two, 10 minutes; and the next two 15 minutes, etc. It is evident then that if the vernier zero is moved, say to the right, until the third line from it (also to the right) is exactly in line with one on the true scale, the movement will be equal to 15 minutes, as indicated by the number opposite this line on the vernier.

2. To read the protractor, first note the number of whole degrees passed by the vernier zero, and then count in the same direction the number of spaces between the vernier zero and that line which exactly coincides with one on the regular scale; this number of spaces multiplied by 5 will give the number of minutes to be added to the whole number of degrees. The reading of a protractor set as illustrated, would be 14 whole degrees plus 30 minutes (14° 30′).

I—BEVEL GEAR FORMULAS

Contributed by Ralph E. Flanders

Bevel Gears with Shafts at Right Angles.



Note: α_p = Pitch Cone Angle of Pinion
α_g = Pitch Cone Angle of Gear
N_p = Number of Teeth in Pinion, etc.

Use Rules and Formulas 1-21 in the order given.

No.	To Find		Rule	Formula
1	Pitch Cone Angle (or Edge Angle) of Pinion		Divide the number of teeth in the pinion by the number of teeth in the gear to get the tangent	$\tan \alpha_p = \frac{N_p}{N_g}$
2	Pitch Cone Angle (or Edge Angle) of Gear		Divide the number of teeth in the gear by the number of teeth in the pinion to get the tangent	$\tan \alpha_g = \frac{N_g}{N_p}$
3	Proof of Calculations for Pitch Cone Angles		The sum of the pitch cone angles of the pinion and gear equals 90 degrees	$\alpha_p + \alpha_g = 90°$
4	Pitch Diameter		Divide the number of teeth by the diametral pitch; or multiply the number of teeth by the circular pitch and divide by 3.1416	$D = \frac{N}{P} = \frac{NP'}{\pi}$
5	These dimensions are the same for both gear and pinion	Addendum	Divide 1.0 by the diametral pitch; or multiply the circular pitch by 0.318	$S = \frac{1.0}{P} = 0.318P'$
6		Dedendum	Divide 1.157 by the diametral pitch; or multiply the circular pitch by 0.368	$S+A = \frac{1.157}{P} = 0.368P'$
7		Whole Depth of Tooth Space	Divide 2.157 by the diametral pitch; or multiply the circular pitch by 0.687	$W = \frac{2.157}{P} = 0.687P'$
8		Thickness of Tooth at Pitch Line	Divide 1.571 by the diametral pitch; or divide the circular pitch by 2	$T = \frac{1.571}{P} = \frac{P'}{2}$
9		Pitch Cone Radius	Divide the pitch diameter by twice the sine of the pitch cone angle	$C = \frac{D}{2 \times \sin \alpha}$
10		Addendum at Small End of Tooth	Subtract the width of face from the pitch cone radius, divide the remainder by the pitch cone radius and muitiply by the addendum	$s = S \times \frac{C-F}{C}$
11		Thickness of Tooth at Pitch Line at Small End	Subtract the width of face from the pitch cone radius, divide the remainder by the pitch cone radius and multiply by the thickness of the tooth at the pitch line	$t = T \times \frac{C-F}{C}$
12		Addendum Angle	Divide the addendum by the pitch cone radius to get the tangent	$\tan \theta = \frac{S}{C}$
13		Dedendum Angle	Divide the dedendum by the pitch cone radius to get the tangent	$\tan \varphi = \frac{S+A}{C}$

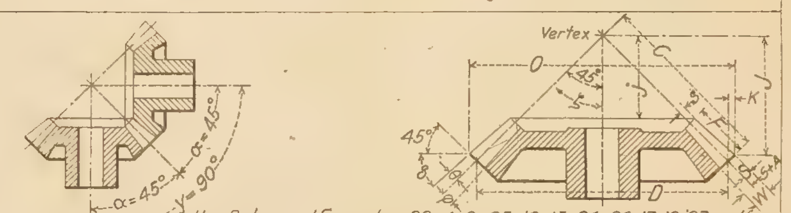
II—BEVEL GEAR FORMULAS

Contributed by Ralph E. Flanders

Bevel Gears with Shafts at Right Angles. (Continued).

No.	To Find	Rule	Formula
14	Face Angle	Subtract the sum of the pitch cone and addendum angles from 90 degrees	$\delta = 90° - (\alpha + \theta)$
15	Cutting Angle	Subtract the dedendum angle from the pitch cone angle	$\zeta = \alpha - \varphi$
16	Angular Addendum	Multiply the addendum by the cosine of the pitch cone angle	$K = S \times \cos \alpha$
17	Outside Diameter	Add twice the angular addendum to the pitch diameter	$O = D + 2K$
18	Apex Distance	Multiply one-half the outside diameter by the tangent of the face angle	$J = \frac{O}{2} \times \tan \delta$
19	Apex Distance at Small End of Tooth	Subtract the width of face from the pitch cone radius, divide the remainder by the pitch cone radius and multiply by the apex distance	$j = J \times \frac{C-F}{C}$
20	Number of Teeth in Equivalent Spur Gear	Divide the number of teeth by the cosine of the pitch cone angle	$N' = \frac{N}{\cos \alpha}$
21	Proof of Calculations by Rules Nos. 9, 12, 14, 16 and 17	The outside diameter equals twice the pitch cone radius multiplied by the cosine of the face angle and divided by the cosine of the dedendum angle	$O = \frac{2C \times \cos \delta}{\cos \theta}$

Mitre Bevel Gearing.



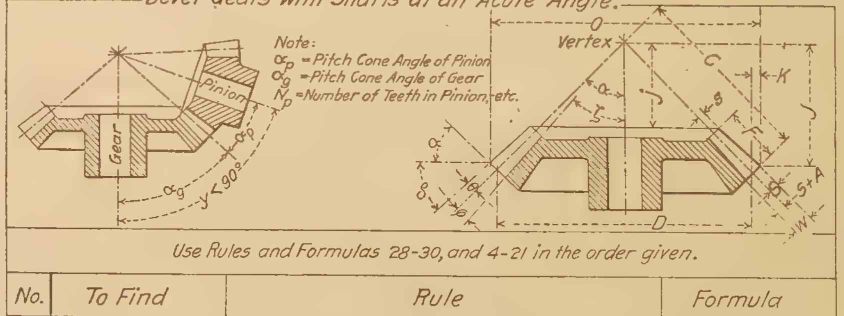
Use Rules and Formulas 22, 4-8, 23, 10-13, 24-26, 17-19, 27 and 21 in the order given. All dimensions thus obtained are the same for both gears of a pair

No.	To Find	Rule	Formula
22	Pitch Cone Angle	Pitch cone angle equals 45 degrees	$\alpha = 45°$
23	Pitch Cone Radius	Multiply the pitch diameter by 0.707	$C = 0.707D$
24	Face Angle	Subtract the addendum angle from 45°	$\delta = 45° - \theta$
25	Cutting Angle	Subtract the dedendum angle from 45 degrees	$\zeta = 45° - \varphi$
26	Angular Addendum	Multiply the addendum by 0.707	$K = 0.707 S$
27	Number of Teeth in Equivalent Spur Gear	Multiply the number of teeth by 1.41	$N' = 1.41N$

III—BEVEL GEAR FORMULAS

Contributed by Ralph E. Flanders

Bevel Gears with Shafts at an Acute Angle.

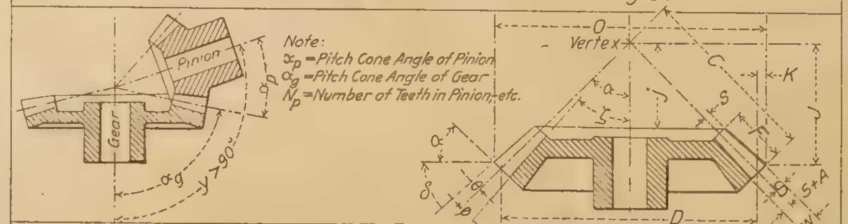


Note: α_p = Pitch Cone Angle of Pinion
α_g = Pitch Cone Angle of Gear
N_p = Number of Teeth in Pinion, etc.

Use Rules and Formulas 28-30, and 4-21 in the order given.

No.	To Find	Rule	Formula
28	Pitch Cone Angle (or Edge Angle) of Pinion	Divide the sine of the center angle by the sum of the cosine of the center angle and the quotient of number of teeth in the gear divided by the number of teeth in the pinion; this gives the tangent	$\tan \alpha_p = \frac{\sin y}{\frac{N_g}{N_p} + \cos y}$
29	Pitch Cone Angle (or Edge Angle) of Gear	Divide the sine of the center angle by the sum of the cosine of the center angle and the quotient of the number of teeth in the pinion divided by the number of teeth in the gear; this gives the tangent	$\tan \alpha_g = \frac{\sin y}{\frac{N_p}{N_g} + \cos y}$
30	Proof of Calculations for Pitch Cone Angles	The sum of the pitch cone angles of the pinion and gear equals the center angle	$\alpha_p + \alpha_g = y$

Bevel Gears with Shafts at an Obtuse Angle.



Note: α_p = Pitch Cone Angle of Pinion
α_g = Pitch Cone Angle of Gear
N_p = Number of Teeth in Pinion, etc.

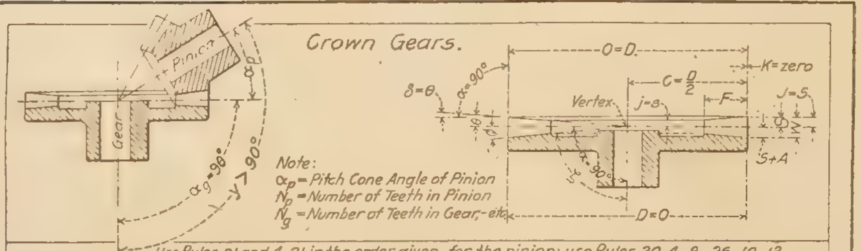
Use Rules and Formulas 31 and 32 as directed below.

No.	To Find	Rule	Formula
31	Pitch Cone Angle (or Edge Angle) of Pinion	Divide the sine of 180 degrees minus the center angle by the difference between the quotient of the number of teeth in the gear divided by the number of teeth in the pinion and the cosine of 180 degrees minus the center angle; this gives the tangent	$\tan \alpha_p = \frac{\sin(180° - y)}{\frac{N_g}{N_p} - \cos(180° - y)}$
32	Whether Gear is a Regular Bevel Gear, a Crown Gear, or an Internal Bevel Gear	Add 90 degrees to the pitch cone angle of the pinion. If the sum is greater than the center angle use rules and formulas 33, 30 and 4-21 in the order given. If the sum equals the center angle see rules and formulas for crown gear. If the sum is less than the center angle see rules and formulas for internal bevel gear.	
33	Pitch Cone Angle (or Edge Angle) of Gear	Divide the sine of 180 degrees minus the center angle by the difference between the quotient of the number of teeth in the pinion divided by the number of teeth in the gear and the cosine of 180 degrees minus the center angle; this gives the tangent	$\tan \alpha_g = \frac{\sin(180° - y)}{\frac{N_p}{N_g} - \cos(180° - y)}$

IV—BEVEL GEAR FORMULAS

Contributed by Ralph E. Flanders

Crown Gears.

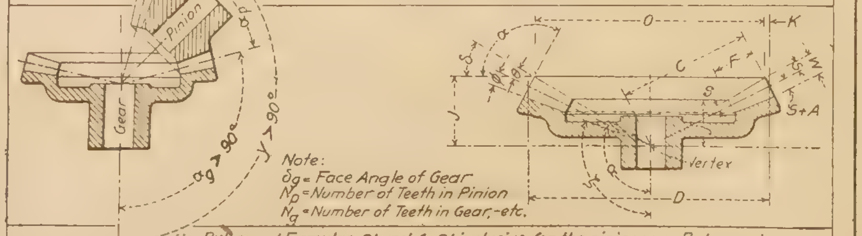


Note:
α_p = Pitch Cone Angle of Pinion
N_p = Number of Teeth in Pinion
N_g = Number of Teeth in Gear, etc.

Use Rules 31 and 4-21 in the order given, for the pinion; use Rules 30, 4-8, 36, 10-13, 37, 15 and 38 in the order given for the crown gear; if dimensions for crown gear are known, to find center angle and dimensions of pinion, use rules and formulas 34, 35 and 4-21 in the order given

No.	To Find	Rule	Formula
34	Pitch Cone Angle (or Edge Angle) of Pinion	Divide the number of teeth in the pinion by the number of teeth in the gear, to get the sine	$\sin \alpha_p = \frac{N_p}{N_g}$
35	Center Angle	Add 90 degrees to the pitch cone angle of the pinion	$y = 90° + \alpha_p$
36	Pitch Cone Radius	Divide the pitch diameter by 2	$C = \frac{D}{2}$
37	Face Angle of Gear	The face cone angle of the gear equals the addendum angle	$\delta_g = \theta$
38	Number of Teeth in Equivalent Spur Gear	The teeth are equivalent in form to rack teeth	$N_g' = \text{infinity}$

Internal Bevel Gears.



Note:
δ_g = Face Angle of Gear
N_p = Number of Teeth in Pinion
N_g = Number of Teeth in Gear, -etc.

Use Rules and Formulas 31 and 4-21 inclusive for the pinion; use Rules and Formulas 39, 30, 40, 41, 15, 42, 43, 18, 19, 44 and 21 in the order given for the gear

No.	To Find	Rule	Formula
39	Pitch Cone Angle (or Edge Angle) of Gear	Divide the sine of 180 degrees minus the center angle, by the difference between the cosine of 180 degrees minus the center angle and the quotient of the number of teeth in the pinion divided by the number of teeth in the gear; subtract the angle whose tangent is thus found from 180 degrees	$\tan \alpha_a = \frac{\sin(180-y)}{\cos(180-y) - \frac{N_p}{N_g}}$ $\alpha_g = 180 - \alpha_a$
40	Pitch Cone Radius	Divide the pitch diameter by twice the sine of 180 degrees minus the pitch cone angle	$C = \frac{D_g}{2 \sin(180 - \alpha_g)}$
41	Face Angle of Gear	Subtract 90 degrees from the sum of the pitch cone angle and the addendum angle	$\delta_g = \alpha_g + \theta - 90°$
42	Angular Addendum of Gear	Multiply the addendum by the cosine of 180 degrees minus the pitch cone angle	$K_g = S \times \cos(180 - \alpha_g)$
43	Outside (or Edge) Diameter of Gear	Subtract twice the angular addendum from the pitch diameter	$O_g = D_g - 2K_g$
44	Number of Teeth in Equivalent Internal Spur Gear	Divide the number of teeth by the cosine of 180 degrees minus the pitch cone angle	$N_g' = \frac{N_g}{\cos(180 - \alpha_g)}$

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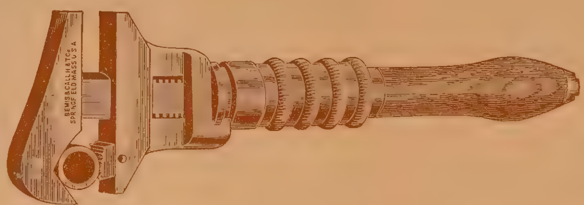

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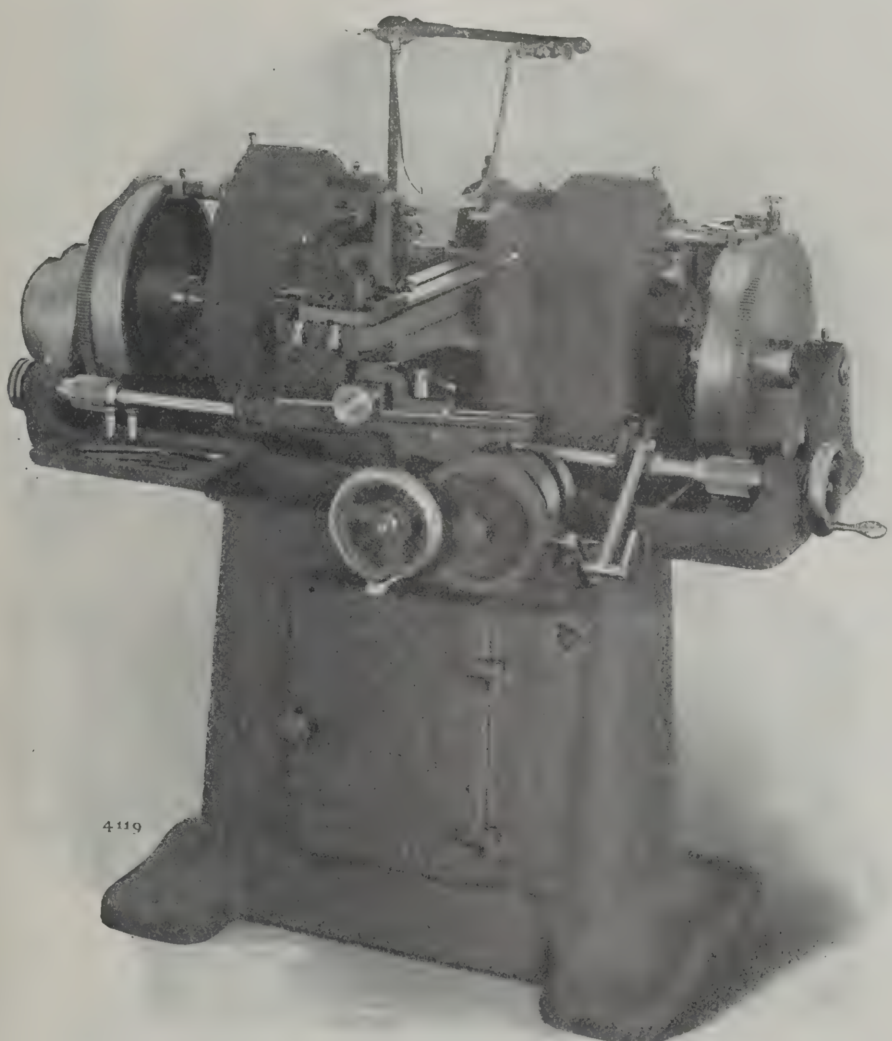

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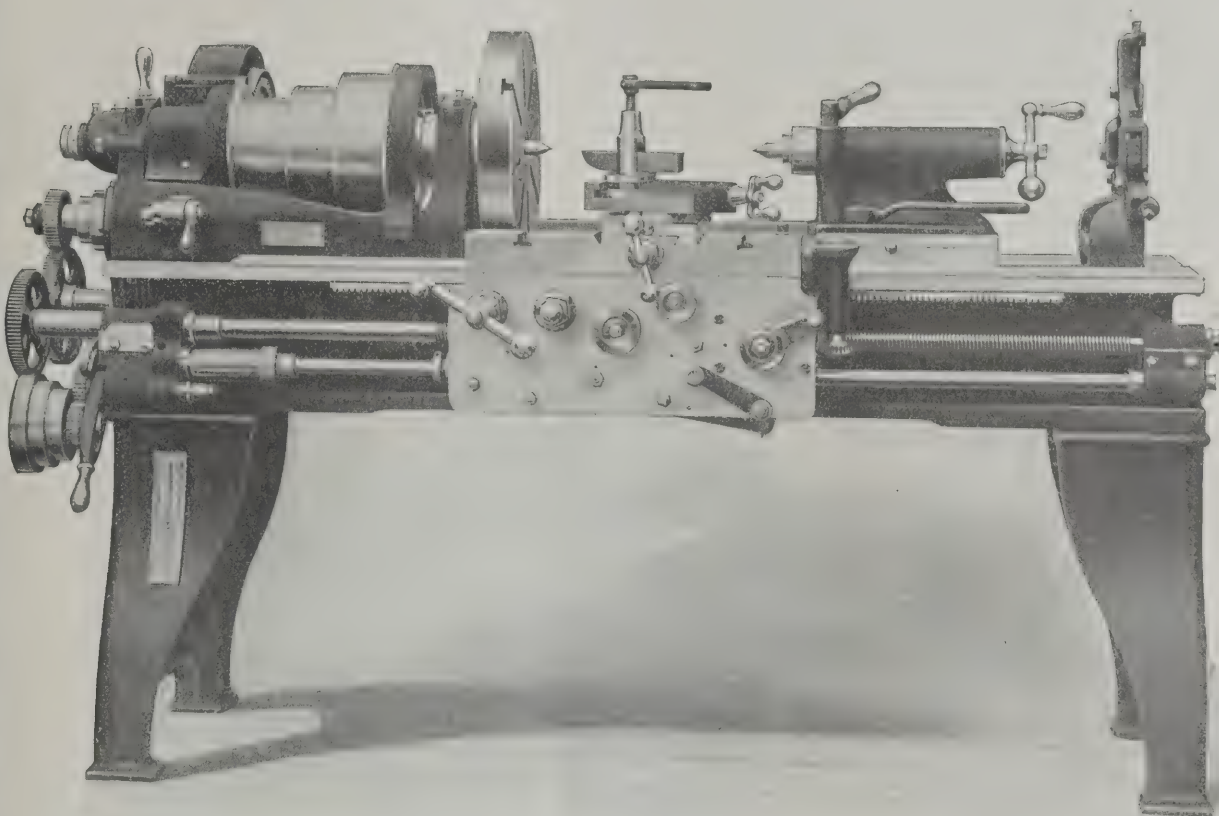

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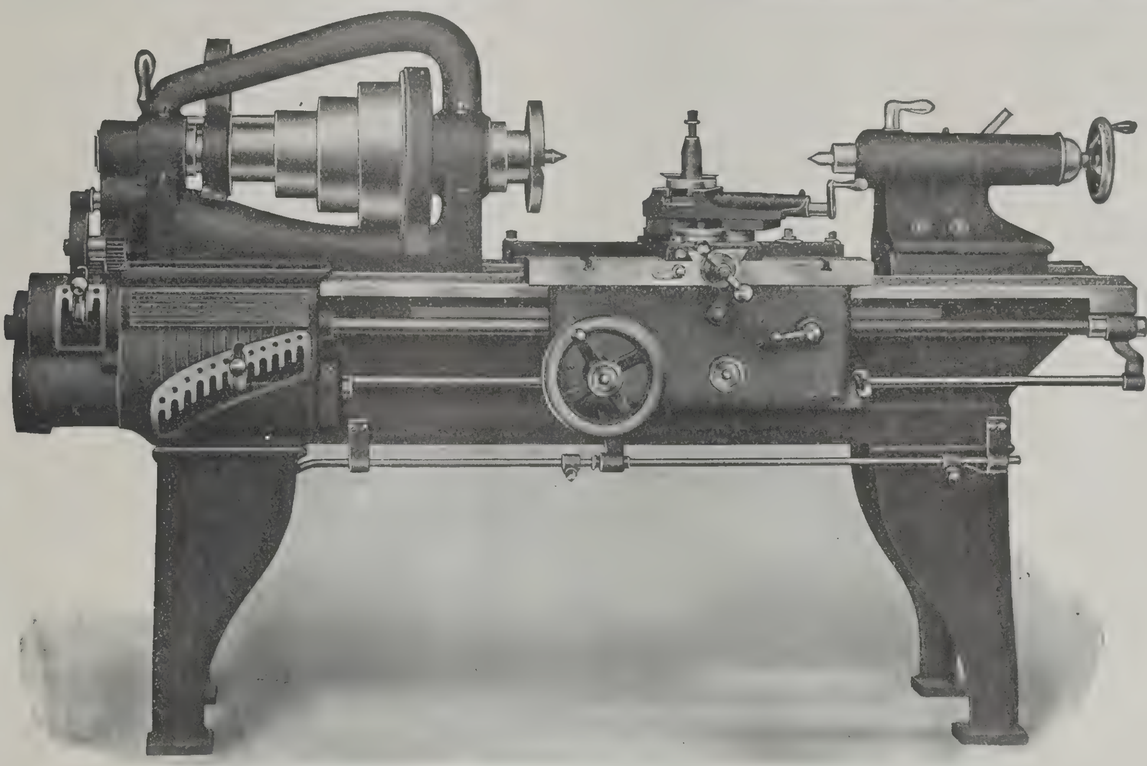

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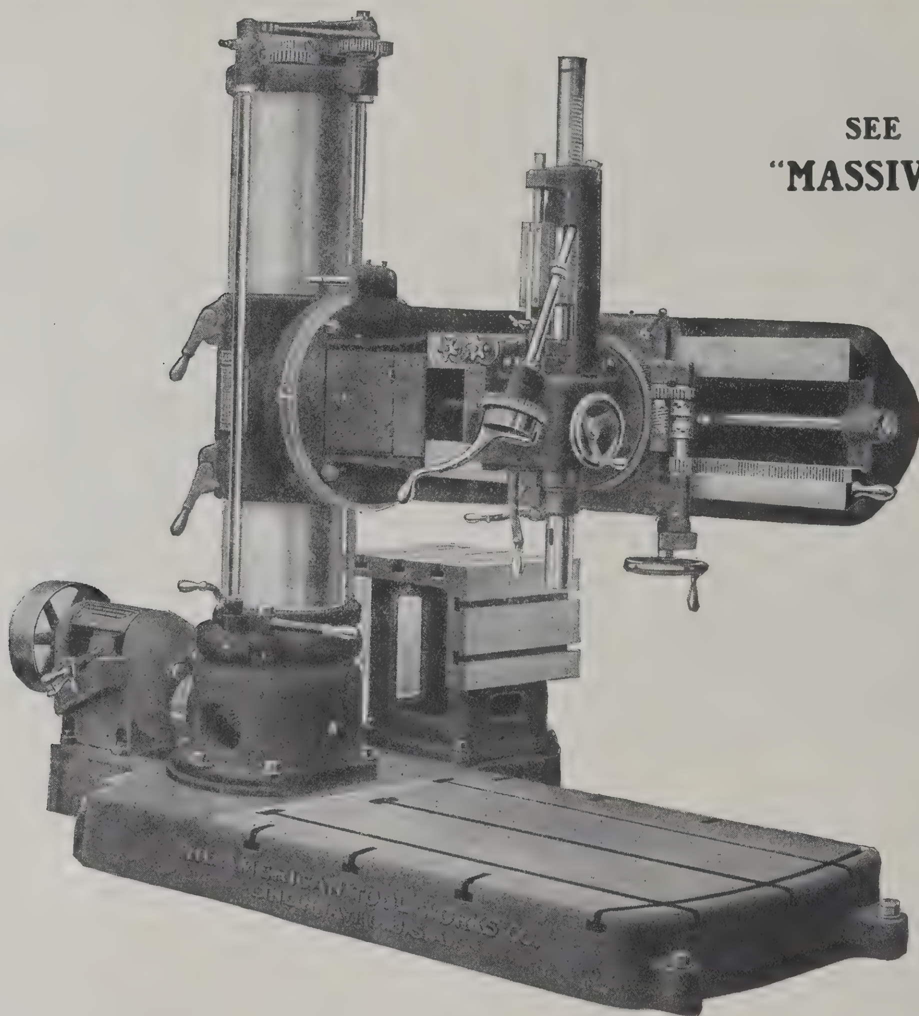

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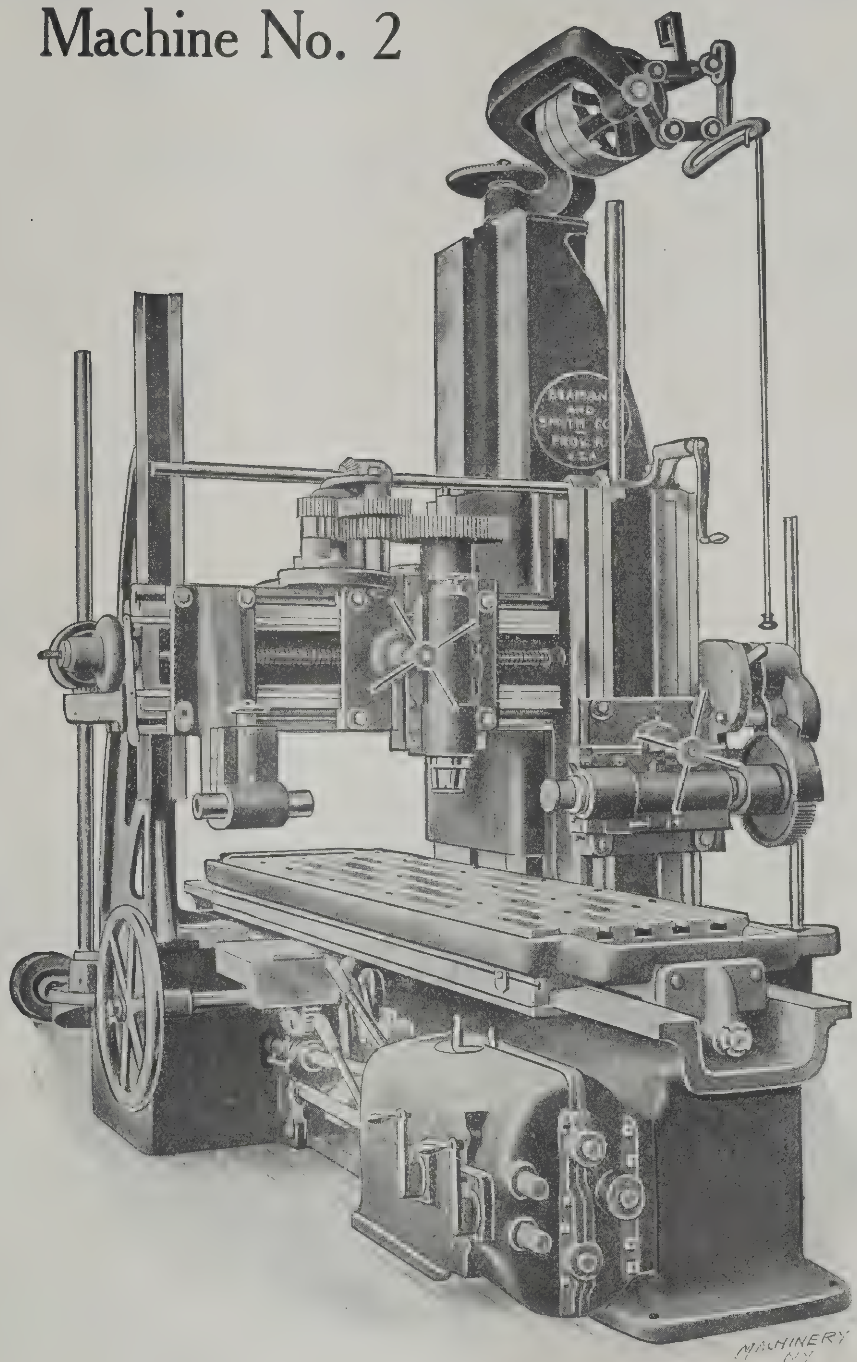

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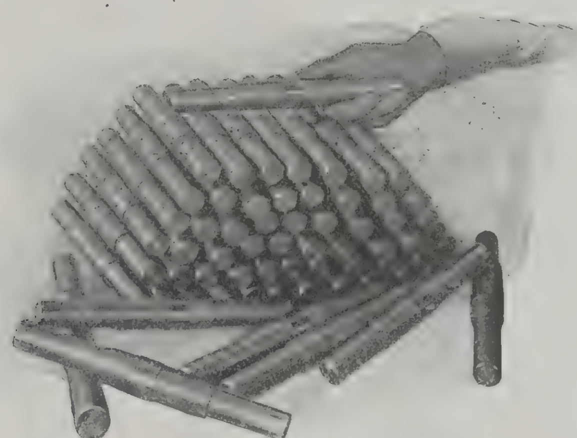

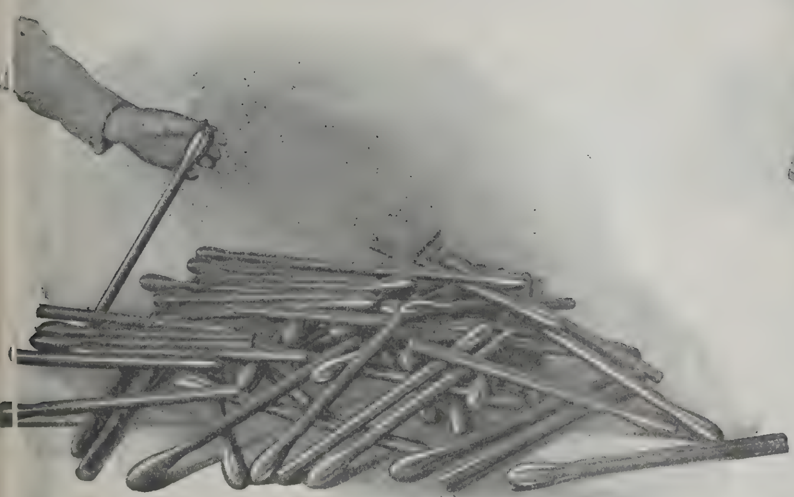

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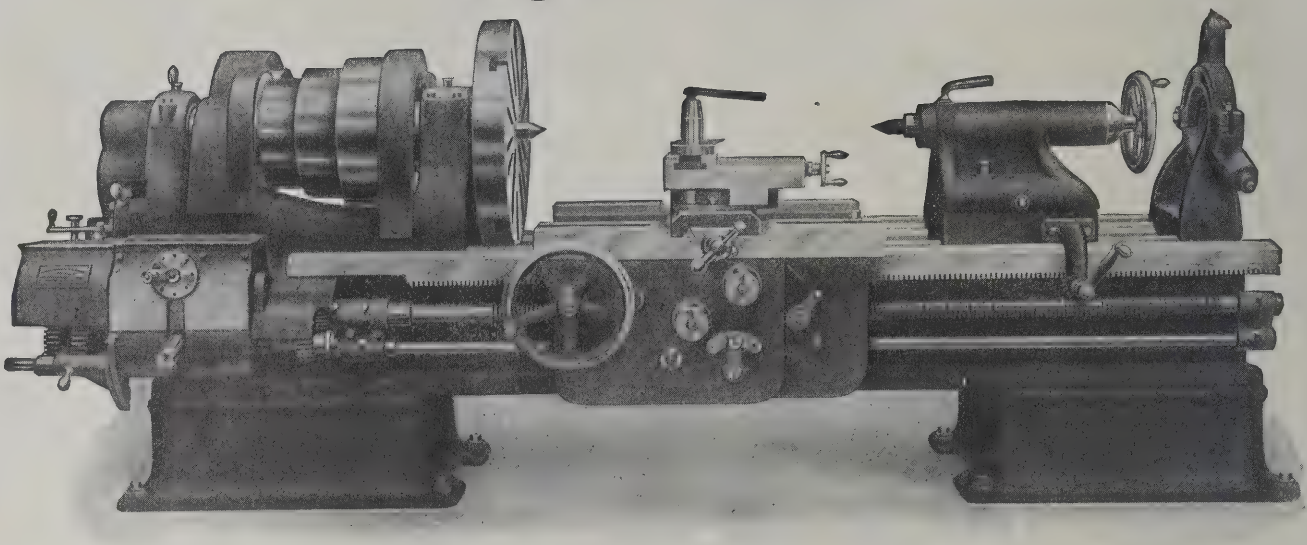

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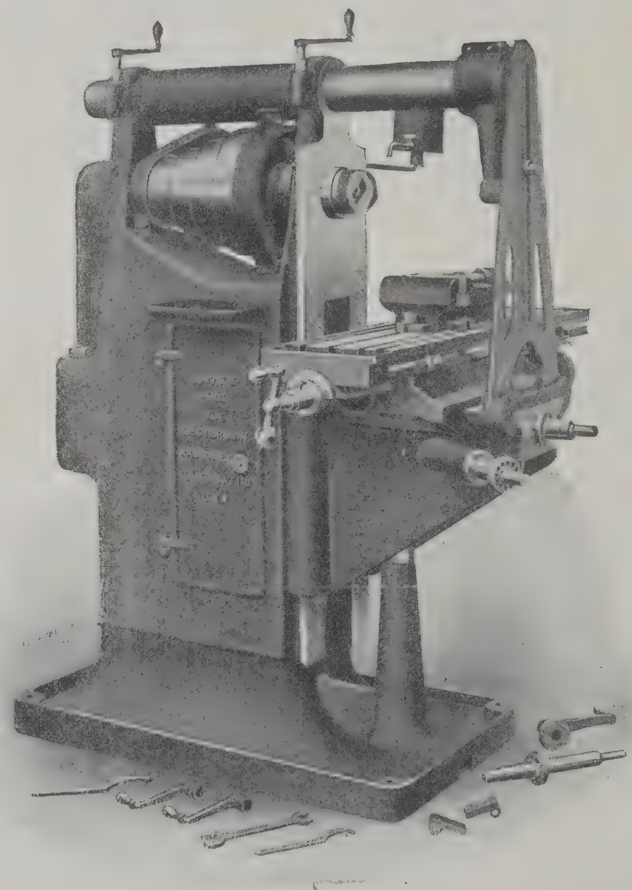

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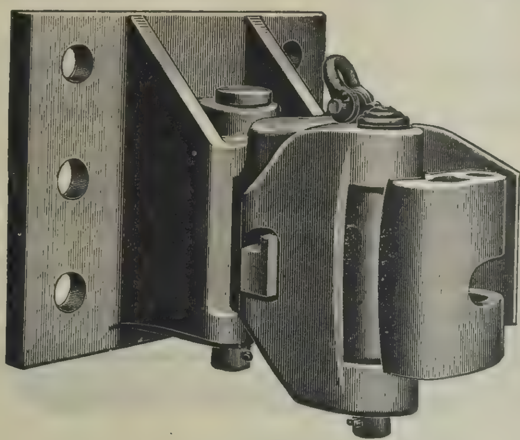

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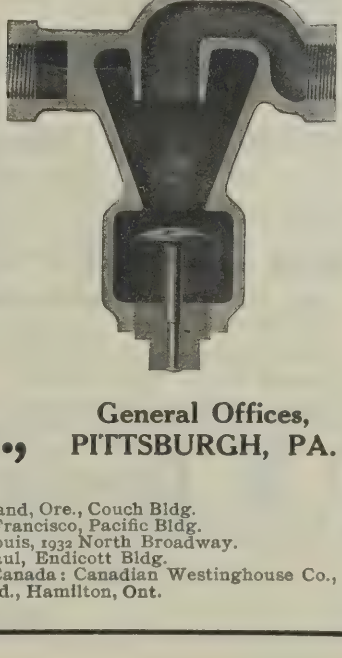

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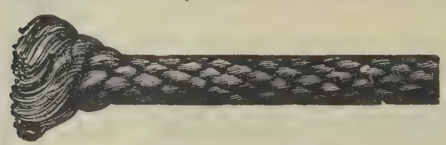

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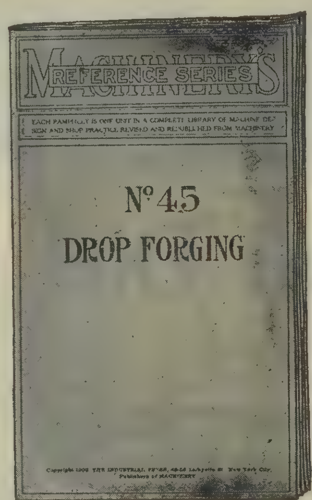

TABLE OF CONTENTS.

Laying out a Drop Forge Plant— Location of Die Sinking Department— Power and Steam Drop Hammers—Helve and Trip Hammers—Layout of the Hardening Department—Kinds of Fuel Oil for Hardening Furnaces — Refitted Coal Forges—Furnaces for Fuel Oil Arrangement of Pipes Drop Forgings—Development of Stamping Processes—Materials Used for Dies—Principles of Drop Forging and Stamping—Removal of Fin produced in Drop Forging—Difference between Treatment of Steel and Wrought Iron—Work with Holes forged through it—Methods of applying Impact or Pressure on Dies – Methods used for making Dies—Drop Forging Work in an Automobile Shop (half tone illustrations) —Making a Drop Forging Die—Tools Employed in making Dies—Tools used for Repairing Dies—Examples of Drop Forging Dies—Trimming Dies - Hardening and Tempering Drop Forging Dies—Concrete Foundations for Drop Hammers.

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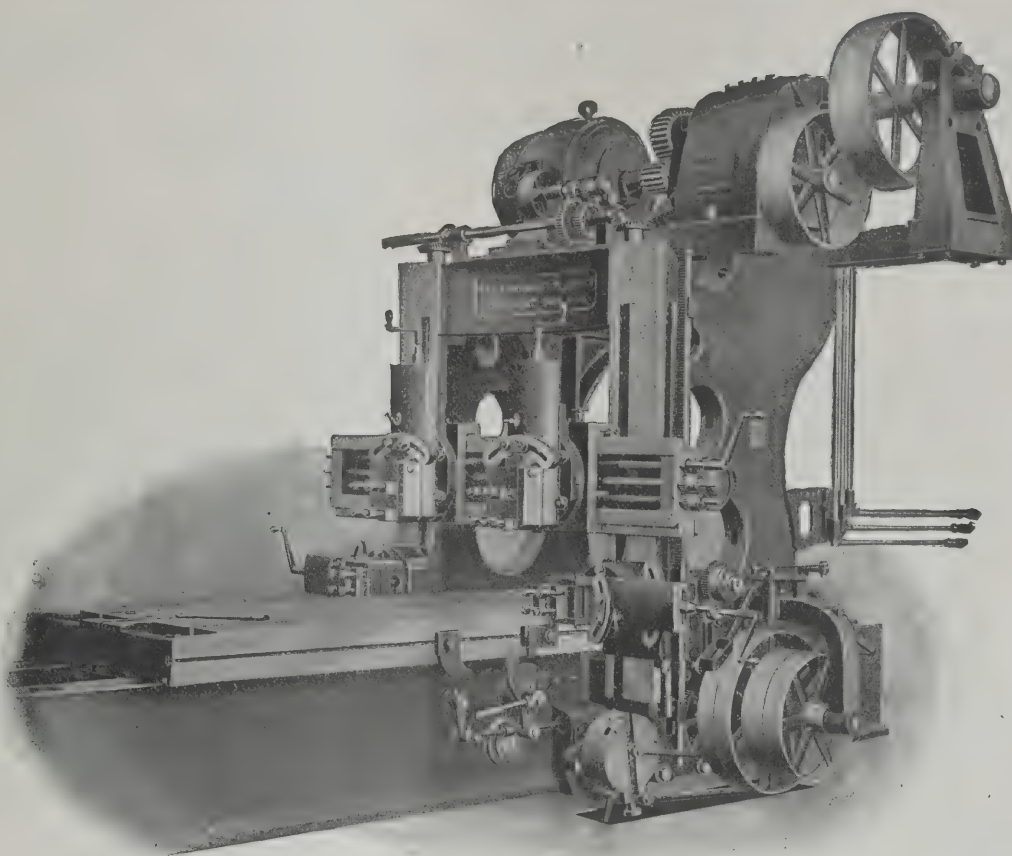

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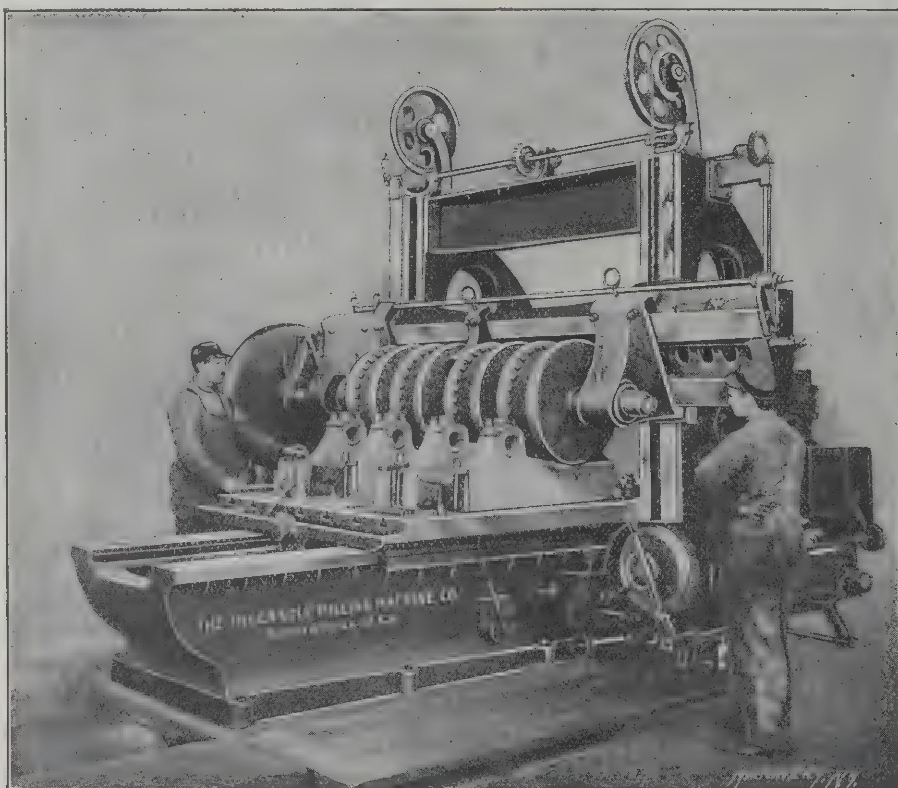
CINCINNATI PLANER CO., Cincinnati, O., U.S.A.

DOMESTIC AGENTS—Prentiss Tool & Supply Co., New York, Syracuse, Boston and Buffalo. Marshall & Huschart Mchy. Co., Chicago, St. Louis and Indianapolis. Motch & Merryweather Mchy. Co., Cleveland, Cincinnati and Detroit. W. E. Shipley Mchy. Co., Philadelphia, Pa. Baird Mchy. Co., Pittsburg, Pa. Harron, Rickard & McCone, San Francisco and Los Angeles, Cal. Hallidie Mchy. Co., Seattle and Spokane. Robinson, Cary & Sands Co., St. Paul and Duluth. Zimmerman, Wells, Brown Co., Portland, Oregon. Galligher Mchy. Co., Salt Lake City. Dewstoe-Lathrop Machinery Co., Birmingham, Ala. Morrison Mchy. & Supply Co., Richmond, Va.

FOREIGN AGENTS—Ludw. Loewe & Co., Berlin and Paris. R. S. Stokvis & Zonen, Rotterdam, Holland and Brussels, Belgium. J. Lambercier & Co., Geneva, Switzerland. Ing. Ercole Vaghi, Milan. E. H. Hunter & Co., Osaka, Japan. Thos. McPherson & Son, Melbourne, Australia.

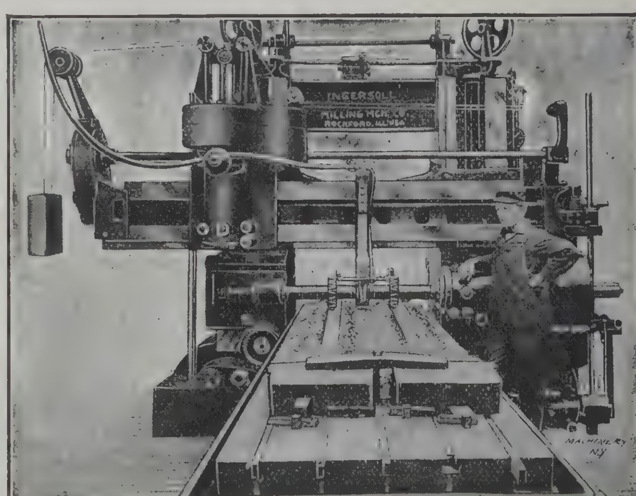
You Can't "Stump" us on a Milling Machine Proposition

We build Milling Machines for every purpose, for light work, for heavy work, for special work—every combination of spindles—every type—every size—and we build Milling Machines exclusively.



Heavy Horizontal Spindle Machine Facing Crank Shaft bearings of Gas Engine. The eight cutters on the arbor are each 24 inches diameter.

Perhaps we can help you out on your milling problem. Our experience covers nearly a quarter century and we have handled some pretty tough jobs in the interim. Glad to advise with you or mail catalog for your inspection.



Combined Horizontal and Vertical Milling Machine, especially valuable for railroad and repair shops. Handles a wide range of work easily and economically. Illustration shows machine at work fluting side rods.

The Ingersoll Milling Machine Co.

Rockford, Illinois, U. S. A.

EASTERN BRANCH:

114 Liberty Street, New York, Walter H. Foster Co, Managers.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, E. C.
F. G. Kretschmer & Co., Frankfort-on-Main, Germany.
Schuchardt & Schutte, Yokohama, Japan.

ALL THERE IS TO
SAY ON A FILE!

NICHOLSON FILE COMPANY, PROVIDENCE, R. I., U.S.A.

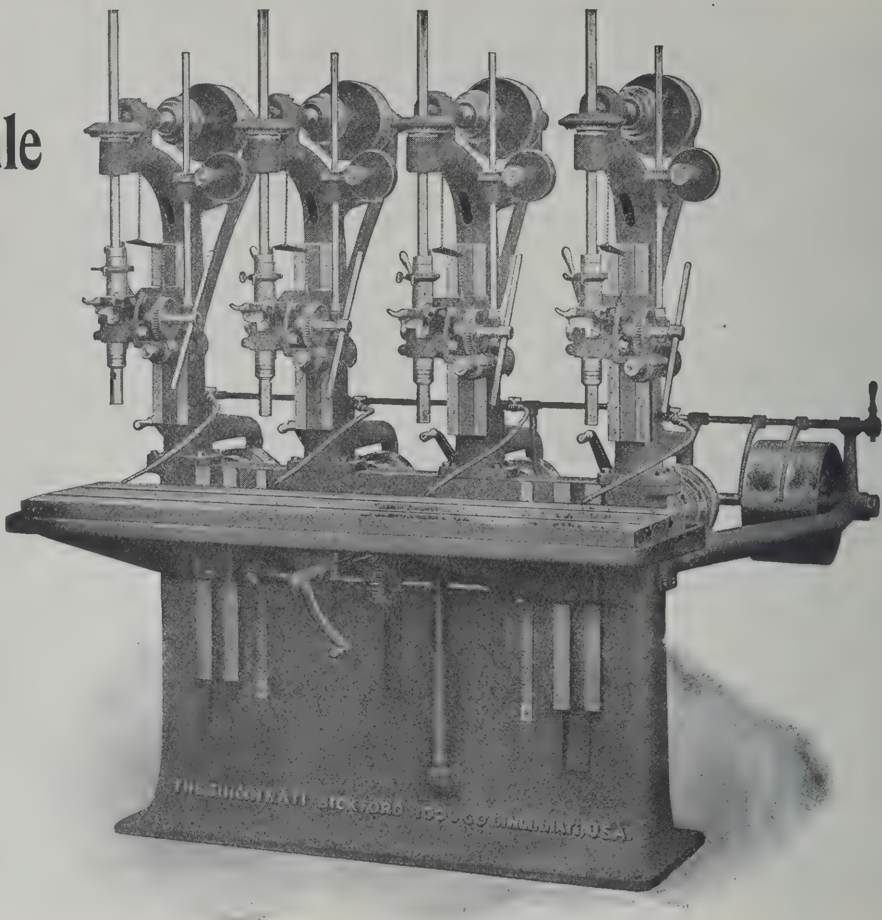
NICHOLSON U.S.A.

FILES FOR EVERY FILING PURPOSE. 3500 STYLES AND SIZES. WRITE FOR CATALOGUE AND A COPY OF "FILE FILOSOPHY."

NICHOLSON U.S.A.

THE CINCINNATI

20-inch Four Spindle High Speed Gang Drilling Machine



Designed for drilling light work rapidly—particularly adapted for drilling holes up to 3/4″ diameter, or for larger holes by using slower feeds. It is heavy and substantial in construction, spindles are powerfully geared, extra large driving belts, insuring ample power to the twist drills. Furnished with 2, 3 or 4 spindles, as desired, with or without power feed. New Circular on request.

Full Line of High Speed Drilling Machinery

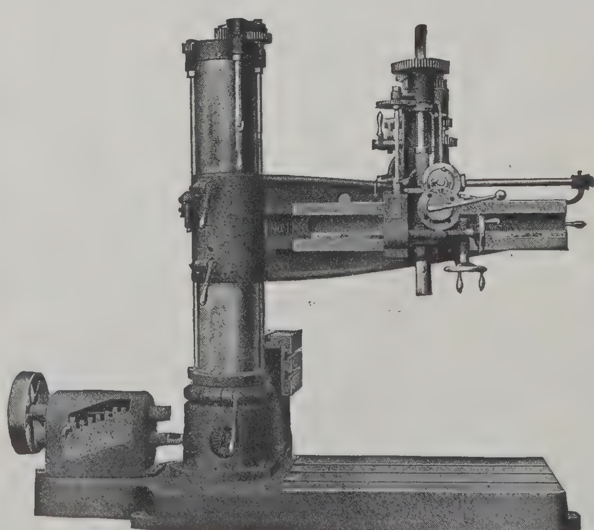
Formerly Manufactured by

Cincinnati Machine Tool Co., and The Bickford Drill & Tool Co.

Now furnished by

The Cincinnati Bickford Tool Co.

CINCINNATI, OHIO



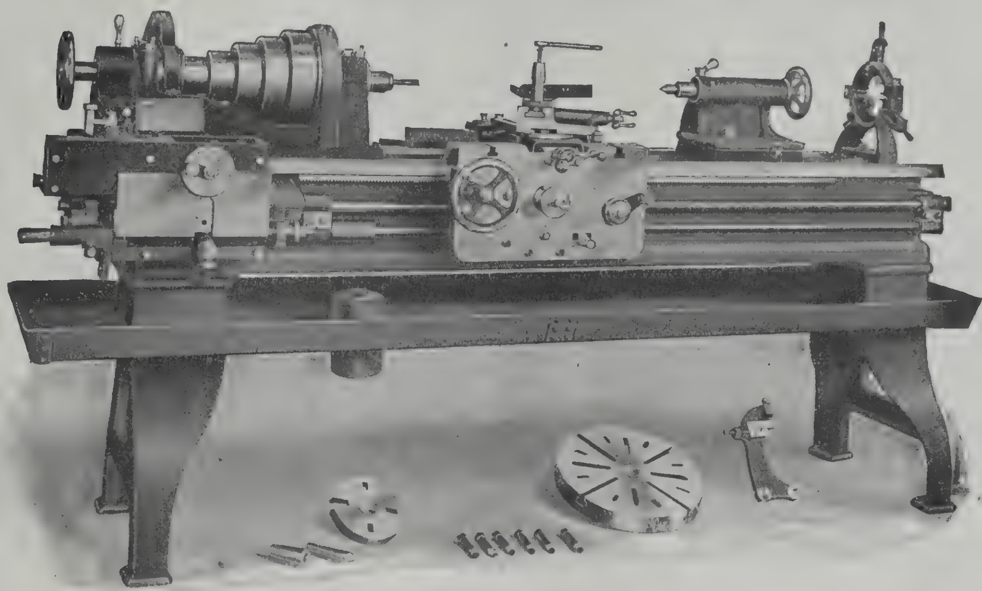
Bickford Improved Radial Drill

Bickford Radials are made in six sizes, from 2½′ to 6′ and in twenty-four styles. Are furnished cone, gear or motor driven, and with any style table—box, swinging or swivel. Simple in design, rigid in construction, easy in operation. Durable, accurate and guaranteed to produce the maximum output. Detailed description for the asking.

Alphabetical Index of Advertisers

VON WYCK 15-INCH TOOL ROOM LATHE

With Patent Instantaneous Change Gear Device

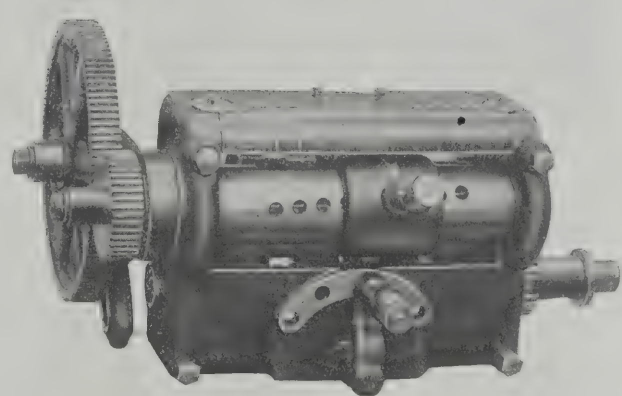


An up-to-date machine for the small, accurate work demanded by tool-room requirements. Every operating convenience, ample power for work within its swing. Fitted with taper attachment. Draw-in Chuck and Oil Pan.

Ask us for the Catalog.

VON WYCK MACHINE TOOL CO., Cincinnati, O., U.S.A.

THE QUICK CHANGE GEAR



applied to our HEAVY DUTY Lathes is made complete in one unit.

Thirty-six changes for threads from 2 to 30, including 11½ pipe are obtained with but two operating levers.

These levers are conveniently located on the front of the lathe with a direct reading index plate immediately above, enabling the operator to determine at a glance the proper setting for any thread or feed.

The mechanism consists of a tumbler operating on a cone of nine gears giving nine changes of speed which are quadrupled by a sliding gear transmission immediately below the cone.

The tumbler plate cannot bind on the large cylindrical bearing and is securely locked in position by a plunger operating through the center of the handle.

The unit construction of this mechanism leaves the end of the Lathe open, permitting the insertion of change gears for chasing special threads when required.

Insist on these money-saving features when buying Lathes.

The R. K. LeBlond Machine Tool Company

CINCINNATI, OHIO

Classified Index to Advertisements.

For Alphabetical Index see page 36.

Classified Index to Advts. (Continued).

Classified Index to Advts. (Continued).

Drying Ovens.
Steiner, E. E., Newark, N. J.
Dynamos.
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Elec. Works, Fort Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Reliance Elect. & Eng. Co., Cleveland, O.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant, B. F., Co., Hyde Park, Mass.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.
Electrotypers.
Lovejoy Co., New York.
Emery and Corundum Wheels.
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Works, Providence, R. I.
Safety Emery Wheel Co., Springfield, O.
Sterling Emery Wheel Mfg. Co., Tiffin, O.
Vitrified Wheel Co., Westfield, Mass.
Emery Wheel Dressers.
Calder, Geo. H., Lancaster, Pa.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Morton Mfg. Co., Muskegon Heights, Mich.
Standard Tool Co., Cleveland, O.
Engines.
Buffalo Forge Co., Buffalo, N. Y.
New Britain Mch. Co., New Britain, Conn.
Sturtevant, B. F., Co., Hyde Park, Mass.
Engines, Gas, Gasoline and Oil.
Foos Gasoline Engine Co., Springfield, O.
Hildreth Mfg. Co., Lansing, Mich.
Otto Gas Engine Wks., Philadelphia, Pa.
Engraving Machines.
Gorton, George, Mch. Co., Racine, Wis.
Exhaust Heads.
Sturtevant, B. F., Co., Hyde Park, Mass.
Factory Equipment.
Lyon Metallic Mfg. Co., Aurora, Ill.
Terrell's Equipment Co., Grand Rapids, Mich.
Van Dorn Iron Wks. Co., Cleveland, O.
Fans, Exhaust, Electric, Ventilating.
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., Schenectady, N. Y.
Reliance Elect. & Eng. Co., Cleveland, O.
Roth Bros. & Co., Chicago, Ill.
Sturtevant, B. F., Co., Hyde Park, Mass.
Ferro-vanadium.
American Vanadium Co., Pittsburg, Pa.
Files.
American Swiss File & Tool Co., New York.
Barnett, G. & H., Co., Philadelphia, Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Hayes File Co., Detroit, Mich.
National File & Tool Co., Philadelphia, Pa.
Nicholson File Co., Providence, R. I.
Reichhelm, E. P., & Co., New York.
Simonds Mfg. Co., Fitchburg, Mass.
Filing Machines.
Robinson Tool Wks., Waterbury, Conn.
Fillet Cutters.
Milwaukee Foundry Supply Co., Milwaukee, Wis.
Fillet (Leather).
Butler, A. G., New York.
Flanges.
National Tube Co., Pittsburg, Pa.
Flexible Shafts.
Coates Clipper Mfg. Co., Worcester, Mass.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Forges.
Billings & Spencer Co., Hartford, Conn.
Buffalo Dental Mfg. Co., Buffalo, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Mchy. Co., Cleveland, O.
Sturtevant, B. F., Co., Hyde Park, Mass.
Forgings, Drop.
Billings & Spencer Co., Hartford, Conn.
Cleveland Crane & Engr. Co., Wickliffe, O.
Hay-Budden Mfg. Co., Brooklyn, N. Y.
Machinery Forging Co., Cleveland, O.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
Williams, J. H., & Co., Brooklyn, N. Y.
Wyman & Gordon, Worcester, Mass.
Forging Machines.
Acme Machinery Co., Cleveland, O.
Ajax Mfg. Co., Cleveland, O.
Beaudry & Co., Boston, Mass.
Bliss, E. W., Co., Brooklyn, N. Y.
National Mchy. Co., Tiffin, O.
Scranton & Co., New Haven, Conn.
Williams, White & Co., Moline, Ill.
Foundry Supplies.
Goldschmidt Thermit Co., New York.
Milwaukee Foundry Supply Co., Milwaukee, Wis.
Obermayer, S., Co., Cincinnati, O.
Friction Cone Pulleys.
Evans, G. F., Newton Center, Mass.
Fuel Economizers.
Sturtevant, B. F., Co., Hyde Park, Mass.
Furnaces, Gas.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Rockwell Furnace Co., New York.
Gauges, Surface, Depth, etc.
Brown & Sharpe Mfg. Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M. Wks., Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb, J. T., Co., Providence, R. I.
Smith, E. G., Co., Columbia, Pa.
Starrett, L. S., Co., Athol, Mass.
Wells Bros. Co., Greenfield, Mass.
Wyke, J., & Co., Boston, Mass.
Gears.
Bilgram Machine Wks., Philadelphia, Pa.
Boston Gear Wks., Norfolk Downs, Mass.
Caldwell, H. W., & Sons Co., Chicago, Ill.
Carpenter-Kerlin Gear & Mch. Co., New York.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Cullman Wheel Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.

The Spindle Bearings

LeBlond Heavy Duty Lathes have **hardened** steel spindle **journals.** These **hardened spindles** run in special **cast iron bearings.**

Do not confuse this with soft spindle, and cast iron bearing construction.

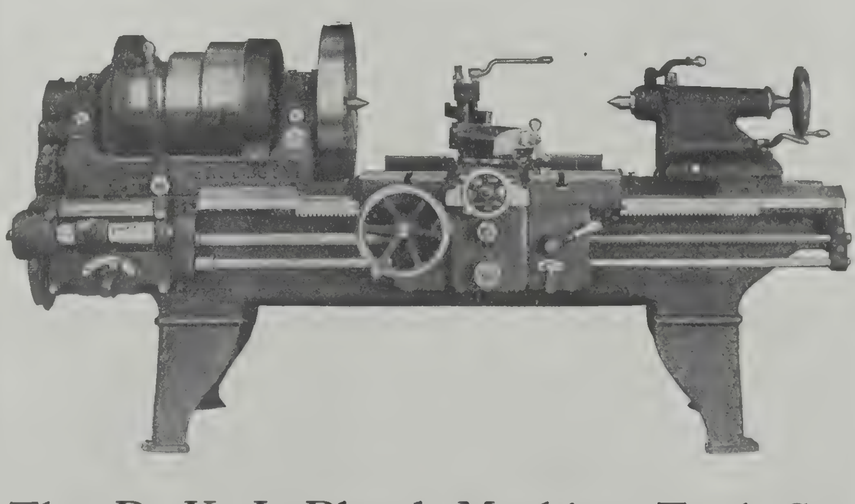
The hardened spindle, and cast iron bearing is the most **efficient,** and **most expensive** bearing ever put in an engine lathe, and will give the best results.

These bearings are **unusually large,** the front bearing on the 16″ lathe illustrated is 3½″ diameter by 4½″ long, reducing the pressure, and presenting large wearing surfaces.

Lubrication is provided by **generous oil wells** from which the oil **filters** to the bearings **through felt pads,** thus insuring a **continuous** supply of **clean** lubricant.

The material of which these bearings is constructed, together with their liberal proportions, and perfect oiling facilities **reduce wear** to a **negligible** quantity insuring **permanent alignment,** and **freedom from chatter,** on the heaviest cuts.

These lathes built in 17″, 19″, 21″, 25″ and 27″ swings are breaking output records daily.



The R. K. LeBlond Machine Tool Co.

CINCINNATI, OHIO

Classified Index to Advts. (Continued).

Heading, Upsetting and Forging Machines.
Acme Machinery Co., Cleveland, O.
Ajax Mfg. Co., Cleveland, O.
Bliss, E. W., Co., Brooklyn, N. Y.
Brown, H. B., Co., East Hampton, Conn.
National Mchy. Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Williams, White & Co., Moline, Ill.
Heating and Ventilating, Dust Collecting Systems.
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant, B. F., Co., Hyde Park, Mass.
Heating Machines.
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Heaters.
Sturtevant, B. F., Co., Hyde Park, Mass.
Heaters, Feed Water.
Stewart Heater Co., Buffalo, N. Y.
Hoisting Machinery.
Detroit Hoist & Mch. Co., Detroit, Mich.
Hoists.
Cleveland Crane & Eng. Co., Wickliffe, O.
Mason, Volney W., & Co., Providence, R. I.
Niles-Bement-Pond Co., New York.
Toledo-Massillon Bridge Co., Toledo, O.
Hoists, Chain.
Harrington, Edwin, & Son, Inc., Philadelphia.
Niles-Bement-Pond Co., New York.
Yale & Towne Mfg. Co., New York.
Hoists, Electric.
Box, Alfred, & Co., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Wks., Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Sprague Elect. Co., New York.
Toledo-Massillon Bridge Co., Toledo, O.
Yale & Towne Mfg. Co., New York.
Hoists, Pneumatic.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Detroit Hoist & Mch. Co., Detroit, Mich.
Northern Engineering Wks., Detroit, Mich.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Stow Flexible Shaft Co., Philadelphia. Pa.
Hydraulic Machinery.
Chambersburg Engineering Co., Chambersburg, Pa.
Niles-Bement-Pond Co., New York.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.
Hydraulic Tools.
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.
Indexes.
Burr Index Co., Hartford, Conn.
Indicators.
Norton Grinding Co., Worcester, Mass.
Starrett, L. S., Co., Athol, Mass.
Woodman, R., Mfg. & Supply Co., Boston, Mass.
Injectors.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Walworth Mfg. Co., Boston, Mass.
Jacks.
Dienelt & Eisenhardt, Philadelphia, Pa.
Irving Mfg. & Tool Co., New York.
Watson-Stillman Co., New York.
Key-Seaters.
Baker Bros., Toledo, O.
Burr, John T., & Sons, Brooklyn, N. Y.
Davis, W. P., Mch. Co., Rochester, N. Y.
Mitts & Merrill, Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Rockford Drilling Mch. Co., Rockford, Ill.
Lamp Guard.
Crescent Co., Chicago, Ill.
Lamps, Electric.
Adams-Bagnall Electric Co., Cleveland, O.
Cooper-Hewitt Electric Co., New York.
General Electric Co., Schenectady, N. Y.
Lathes.
American Tool Works Co., Cincinnati, O.
Automatic Mch. Co., Bridgeport, Conn.
Barnes, W. F. & J., Co., Rockford, Ill.
Barnes Drill Co., Rockford, Ill.
Bradford Machine Tool Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Mch. Tool Co., Bridgeport, Conn.
Champion Tool Wks. Co., Cincinnati, O.
Cincinnati Lathe and Tool Co., Cincinnati, O.
Davis, W. P., Mch. Co., Rochester, N. Y.
Detrick & Harvey Mch. Co., Baltimore, Md.
Elgin Tool Works, Elgin, Ill.
Fay Mch. Tool Co., Philadelphia, Pa.
Fay & Scott, Dexter, Me.
Fitchburg Mch. Wks., Fitchburg, Mass.
Flather & Co., Nashua, N. H.
Gisholt Mch. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Greaves, Klusman & Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Hardinge Bros., Chicago, Ill.
Hendey Mch. Co., Torrington, Conn.
International Mch. Tool Co., Indianapolis, Ind.
Jones & Lamson Mch. Co., Springfield, Vt.
Le Blond, R. K., Mch. Tool Co., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
Miami Valley Mch. Tool Co., Dayton, O.
Milwaukee Mch. Tool Co., Milwaukee, Wis.
Morris, J. B., Fdry. Co., Cincinnati, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Potter & Johnston Mch Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rahn-Carpenter Co., Cincinnati, O.
Reed, F. E., Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Brighton, Mass.
Robbins Mch. Co., Worcester, Mass.
Rockford Drilling Mch. Co., Rockford, Ill.
Schumacher & Boye, Cincinnati, O.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mch. Tool Co., Springfield, O.
Steinle Turret Mch. Co., Madison, Wis.

Classified Index to Advts. (Continued).

Classified Index to Advts. (Continued).

Reliance Elect. & Eng. Co., Cleveland, O.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant, B. F., Co., Hyde Park, Mass.
Wagner Electric Mfg. Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Nozzles.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Numbering Machines.
Bates Numbering Mch. Co., Brooklyn, N. Y.

Nut Tappers.
Acme Mchy. Co., Cleveland, O
National Mchy. Co., Tiffin, O.

Oil Cans.
Delphos Mfg. Co., Delphos, O.

Oil Cups.
Bay State Stamping Co., Worcester Mass.
Besly, C. H., & Co., Chicago, Ill.
Tucker, W. M. & C. F., Hartford, Conn.
Winkley Co., Detroit, Mich.

Oil Hole Covers.
Bay State Stamping Co., Worcester, Mass.
Tucker, W. M. & C. F., Hartford, Conn.
Winkley Co., Detroit, Mich.

Oilless Bearings.
Arguto Oilless Bearing Co., Philadelphia, Pa.

Oil Stones.
Norton Co., Worcester, Mass.

Packing.
Houghton, E. F., & Co., Philadelphia, Pa.
New York Belting and Packing Co., New York.

Paints and Varnishes.
Devoe, F. W., & Co., New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.

Pattern Letters.
Butler, A. G., New York.

Patents.
Burnham, Royal E., Washington, D. C.
Howson & Howson, Philadelphia, Pa.
Parker, C. L., Washington, D. C.
Whittlesey, Geo. P., Washington, D. C.

Pattern-Shop Equipment.
Fox Machine Co., Grand Rapids, Mich

Phosphorizers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Pipe-Cutting and Threading Tools.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Hart Mfg. Co., Cleveland, O.
Landis Mch. Co., Waynesboro, Pa.
Loew Mfg. Co., Cleveland, O.
Merrell Mfg. Co., Toledo, O.
Murchey Mch. & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Saunders, D., Sons, Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Myerstown, Pa.
Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.
Wells, F. E., & Son Co., Greenfield, Mass.

Pipes and Fittings.
National Tube Co., Pittsburg, Pa.
Walworth Mfg. Co., Boston, Mass.

Planers, Metal.
American Tool Wks. Co., Cincinnati O.
Betts Mch. Co., Wilmington, Del.
Cincinnati Planer Co., Cincinnati, O.
Cleveland Crane & Engr. Co., Wickliffe, Ohio.
Cleveland Planer Wks., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather, Mark, Planer Co., Nashua, N. H.
Gleason Works, Rochester, N. Y.
Gray, G. A., Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Knecht Planer Co., Cincinnati, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Rockford Mch. Tool Co., Rockford, Ill.
Schneider, Fred., Mch. Tool Co., Cincinnati, O.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.
Wilson, W. A., Mch. Co., Rochester N. Y.
Woodward & Powell Planer Co., Worcester, Mass.

Portable Tools Repair, Railroad, etc.
Underwood, H. B., & Co., Philadelphia, Pa.

Pneumatic and Turntable Motors.
Detroit Hoist & Mch. Co., Detroit, Mich.

Pneumatic Tools.
Bliss, E. W., Co., Brooklyn, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Shepard Elec. Crane & Hoist Co., Montour Falls.

Presses.
Ams, Max, Machine Co., Mount Vernon, N. Y.
Billings & Spencer Co., Hartford, Conn.
Bliss, E. W., Co., Brooklyn, N. Y.
Ferracute Mch. Co., Bridgeton, N. J.
Hamilton Mch. Tool Co., Hamilton, O.
Hoefer Mfg. Co., Freeport, Ill.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Swaine, F. J., Mfg. Co., St. Louis, Mo.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Presses, Power Forcing.
Lucas Machine Tool Co., Cleveland, O.

Pulley Blocks.
Yale & Towne Mfg. Co., New York.

Pulleys.
American Pulley Co., Philadelphia, Pa.
Brown & Sharpe Mfg. Co, Providence, R. I.
Philips Pressed Steel Co., Philadelphia, Pa.
Poole Engr. & Mch. Co., Baltimore, Md.
Reeves Pulley Co., Columbus, Ind.
Saginaw Mfg. Co., Saginaw, Mich.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Wood's, T. B., Sons Co., Chambersburg, Pa.

Pumps.
Brown & Sharpe Mfg. Co., Providence, R. I.
Buffalo Forge Co., Buffalo, N. Y.
Leiman Bros., New York.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Classified Index to Advts. (Continued).

Classified Index to Advts. (Continued).

Classified Index to Advts. (Continued).

For Alphabetical Index see page 36.

To Prevent Exposed Iron Rusting.

To prevent iron which is exposed to moisture from rusting, paint over with a coat of Portland liquid cement. This is very satisfactory for posts which are set in the ground.

—From MACHINERY'S popular booklet "150 Shop Receipts and Formulas." Write for descriptive pamphlet.

POTTER & JOHNSTON MANUFACTURING AUTOMATICS

Cut below shows a Battery of Thirty-one (31) Automatics installed in one of the leading automobile shops. This is nothing extraordinary, however, as some shops are using as many as fifty machines, others seventy-five machines.

For all duplicate work ranging in diameter from 2 inches up to 20 inches and up to 10 inches long—either cast iron, steel, bronze, or forgings—POTTER & JOHNSTON MANUFACTURING AUTOMATICS can be employed to advantage.

One Attendant Operates from Two to Six Automatics.

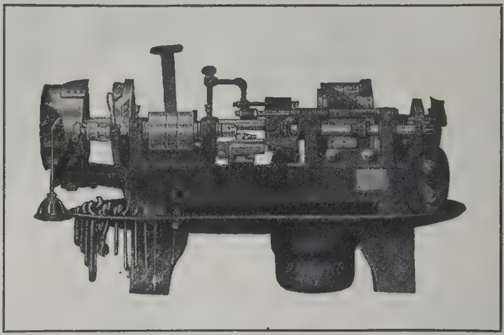
"The proof of the pudding is in the eating of it." Send us samples or drawings of your work and we will cheerfully show you what the Manufacturing Automatics will do.

POTTER & JOHNSTON, Pawtucket, R. I., U. S. A.

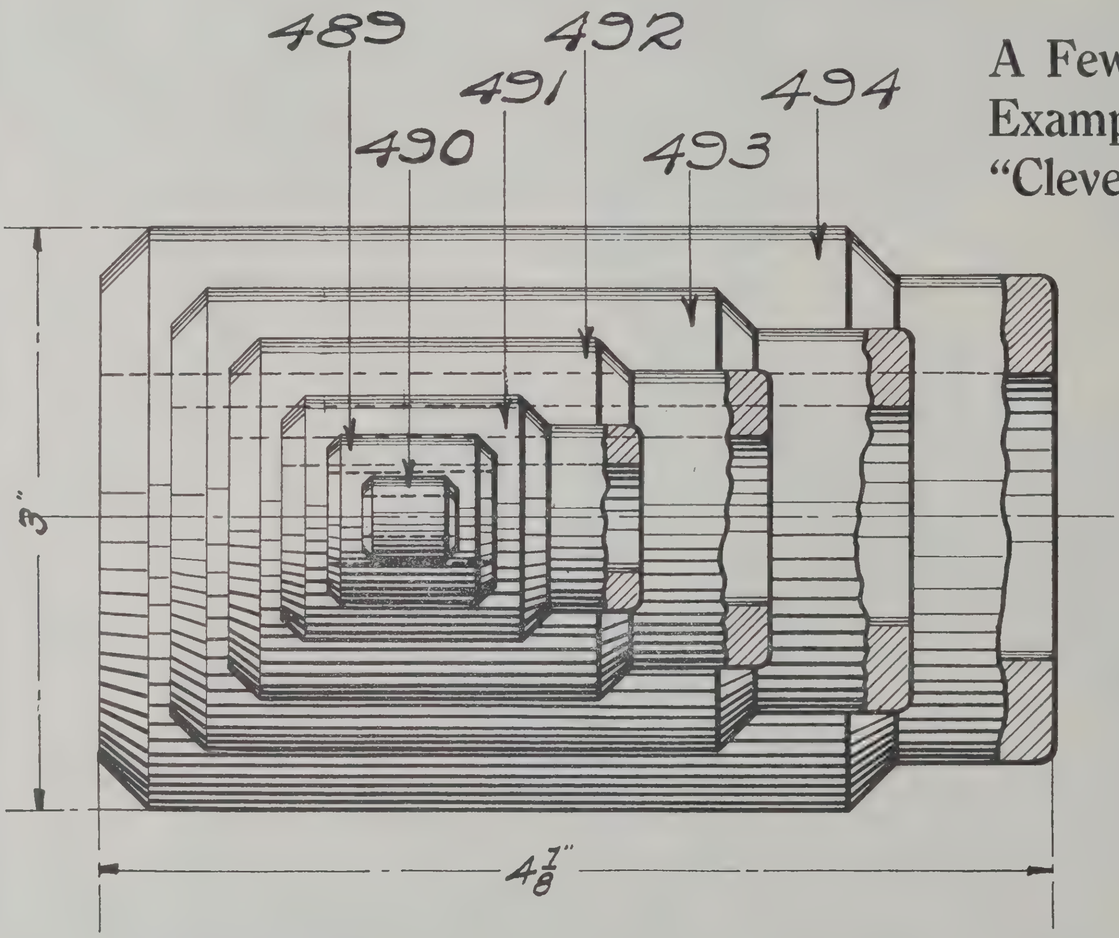
OFFICES AND REPRESENTATIVES—Office for Great Britain and France: 78 Avenue de la Grande Armee, Paris, J. Ryan, Manager. New York Office: Fulton Bldg., 50 Church St., Walter H. Foster, Manager. Cleveland Office: Modern Machinery and Engineering Co., 309 Schofield Bldg. Milwaukee Office: 794 National Avenue, Chas. H. Shaw, Manager.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England, and Glasgow, Scotland. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Barcelona, Bilbao. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen, Budapest.

The Pre-eminence of the "Cleveland" is Indisputable



Their range is not confined to any one class of work, versatility being a strong point, but on worms, screws and small parts from the bar, they outclass all competitors. Efficiency and economy go hand in hand with the Cleveland. One of the biggest manufacturers of screws, machine parts, etc., in the country has considerably more than a hundred Automatics in the plant, not only turning out the most satisfactory work, but with continuous running, in a year's time the repair account did not show \$10.00 outlay. Compare this with the record of the average machine—and then look over our Red Catalogue—yours for the asking.



A Few Examples of "Cleveland" Work

Cold Rolled Steel Worms

Output on each piece as follows

Piece 489—output 22 per hour
Piece 490—output 35 per hour
Piece 491—output 12 per hour
Piece 492—output 8 per hour
Piece 493—output 5 per hour
Piece 494—output 3 per hour

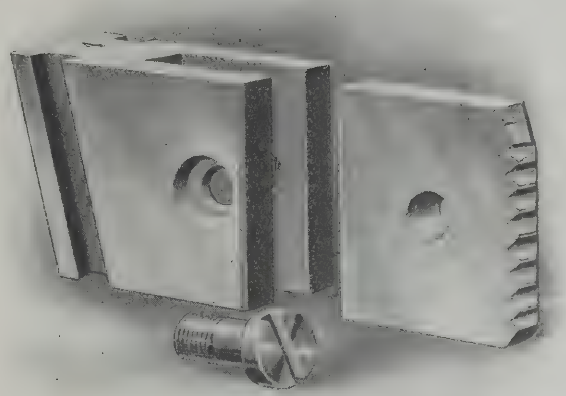
Send us samples or drawings, we will send you complete specifications, cost of machines, tools, etc.

Capacities 1" to 6¾". Operating Expense One Mill a Minute. Your overhead charges added to this will give you the exact cost per piece.

Cleveland Automatic Machine Co., Cleveland, O., U.S.A.

Eastern Representative—J. B. Anderson, 2450 No. 30th St., Philadelphia. Western Representative—Herbert E. Nunn, 562 Washington Boulevard, Chicago. Foreign Representatives—Chas. Churchill & Co., London, Manchester, Birmingham, New-castle-on-Tyne and Glasgow. Messrs. Schuchardt & Schutte, Vienna, Berlin, St. Petersburg, Stockholm, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milano and Bilbao.

The Die Question



The National Interchangeable Case Die

A Die in which Chasers interchange from case to case and always insure perfect thread cutting. The Chaser requires minimum cutting steel, hence first cost is low. The cutting face is wide and permits more resharpenings than can be secured from the ordinary Die.

?

IN a terse, interesting eight-page booklet we have set forth the good features of a Bolt Cutter Die that for **4** years has undergone crucial tests in Railroad and industrial shops—comparative tests, under all conditions against all kinds of Threading Dies and Equipment.

¶ The verdict, in substance, of the threading expert today is that the

NATIONAL INTERCHANGEABLE CASE DIE

is better by 50 PER CENT. than any Threading Die offering. Better by 50 PER CENT. in economy of maintenance, productive capacity, and all around threading ability. Features that are all important to Bolt Cutter users.

¶ We are distributing the booklet to Bolt Cutter users, operators, and to the man who appreciates modern practice in thread cutting, considered from economy's view-point.

¶ The booklet tells in facts and figures the strong features that lend to make this the present-day economical Bolt Cutter Die.

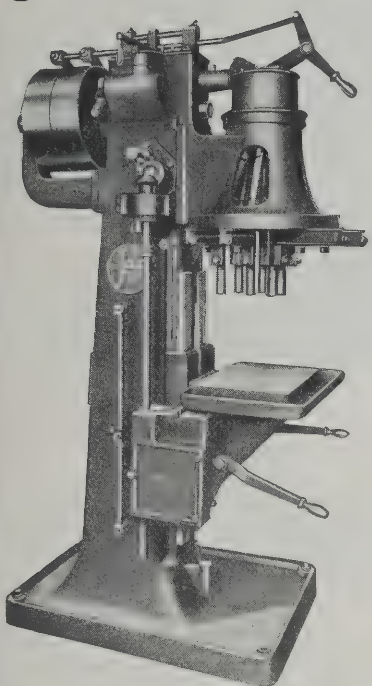
¶ A copy, if you'll address Dept. "E."

TRADE THE NATIONAL MACHINERY CO TIFFIN, OHIO, U.S.A. MARK

THE NATIONAL MACHINERY CO.
TIFFIN, OHIO, U. S. A.

We build the best Bolt, Nut, Rivet and Forging Equipment for Railroad and Industrial demands.
Also Wire Nail Machinery.

FOX MULTIPLE SPINDLE DRILLS



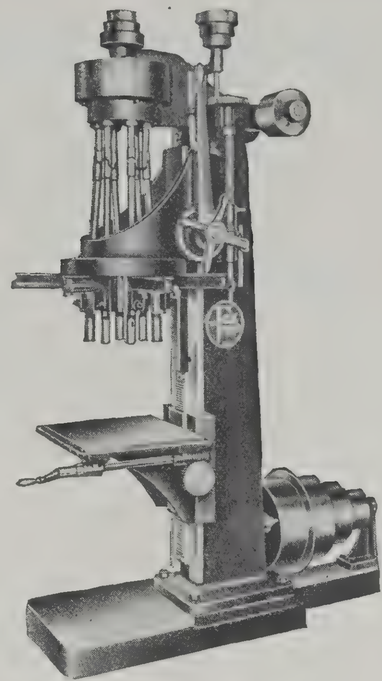
No. 2 Drill.

Our No. 1, 2 and 3 drills are rapid producers of duplicate parts.

No. 4 machine drills 18 holes ½″ diam. Layout 16″ x 20″.

No. 5 machine drills 13 holes ⅞″ diam. Layout 16″ x 30″

No. 2, 3, 4, and 5 machines full geared driven spindles and feed.



No. 1 Drill.

Write for Catalog.

FOX MACHINE COMPANY
1602 Front Street
GRAND RAPIDS, MICH., U. S. A.

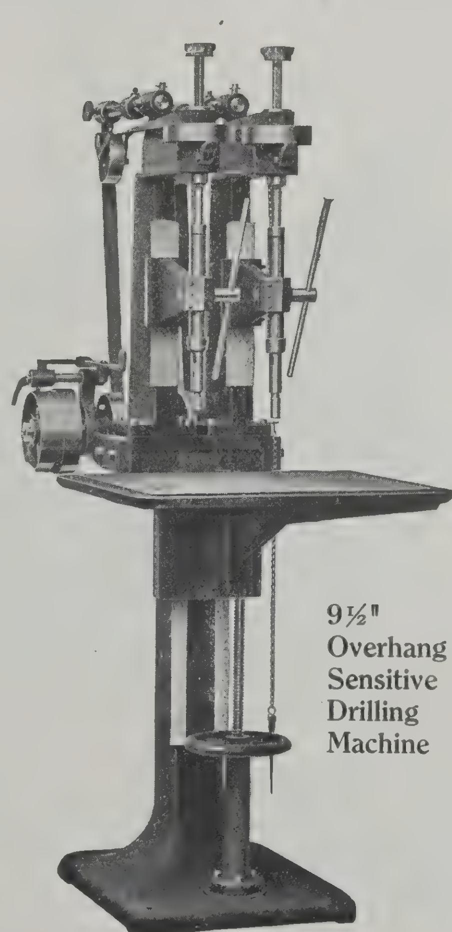
The Wide Range of Work

For which our wide Overhang Ball Bearing Drilling Machine has capacity is quite without equal. Anything that could be drilled on the older machines is easily handled on the wide range and a vast amount of work that formerly could not be touched.

The enormous advantage of the greater overhang, and the correspondingly larger table, is obvious to every manufacturer. The new arrangement permits jig work of various descriptions to be handled, large parts drilled—greater capacity in every way, and the price of the machine is nearly the same.

Write us for full particulars. We can increase your drilling output **200 to 400 per cent** with our Drilling Machines and drill a wider range of work in the bargain.

9½″, 12″ and 15″ Overhang.



9½″ Overhang Sensitive Drilling Machine

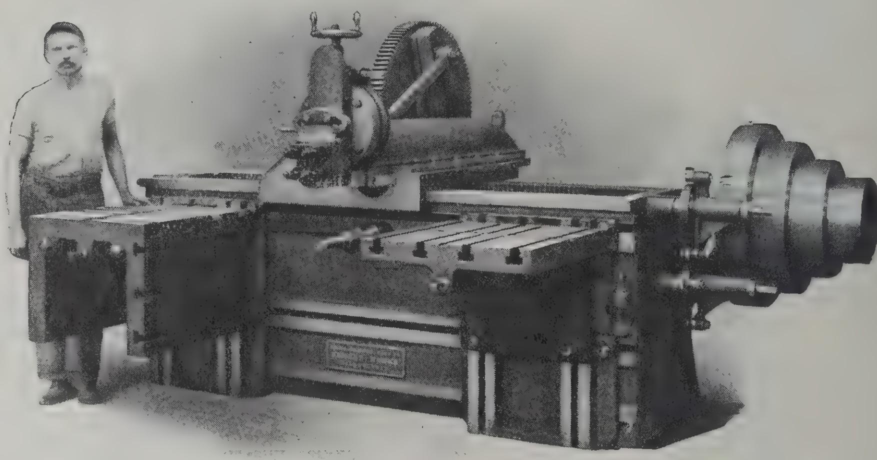
The Henry & Wright Mfg. Company
HARTFORD, CONN.

For Heavy Continuous Work on Steel or Cast Iron.

Bement Shapers

have the back bone to stand up under the strain of the best high power steel tools.

The powerful drive on the belt driven machines consists of a driving train of only one spur gear and pinion, both cut with a special cutter to eliminate back lash.



1776

26-in. Bement Single Traveling Head Shaping Machine.

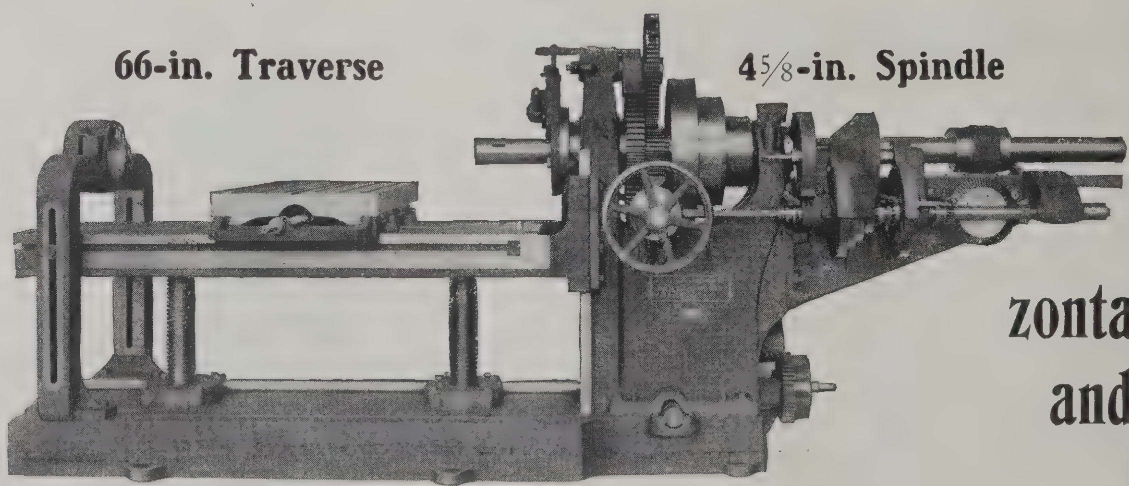
Three sizes. One or two traveling heads. Belt or motor drive.

Write for Catalog "Shapers."

Convertible from Belt to Motor Drive at Any Time

66-in. Traverse **4⅝-in. Spindle**

The Bement Horizontal Boring and Drilling Machine



1504

Six automatic reversible feeds for boring and drilling. Rapid hand adjustment. Sixteen speeds. Main table operated by power.

Write for Catalog "Horizontal Boring Machines."

Niles Electric Traveling Cranes

NILES - BEMENT -

111 BROADWAY, NEW YORK, U. S. A.

SALES OFFICES—Boston, Oliver Bldg. Chicago, Commercial National Bank Bldg. Pittsburgh, Frick Bldg. St. Louis, 516 No. Third St. Philadelphia, 21st St. John, Toronto, Calgary, Winnipeg and Vancouver, Agents for California, Nevada and St., Los Angeles, Cal. Italy, Ing. Ercole Vaghi, Milan. Germany, F. G.

For Exact Drilling

From Centre to Centre of Holes

Niles Multiple Drilling Machines

Built with 2 to 8 spindles or more to meet requirements.

Each drill head has independent adjustments, and drive and feed clutches.

Illustration shows a Niles 6-Spindle Drill with compound movement of table and power elevating gears. Maximum diameter of drills, all working, 1 1/4 in.

Write for illustrated Circulars.

Do Not Reset Difficult Settings

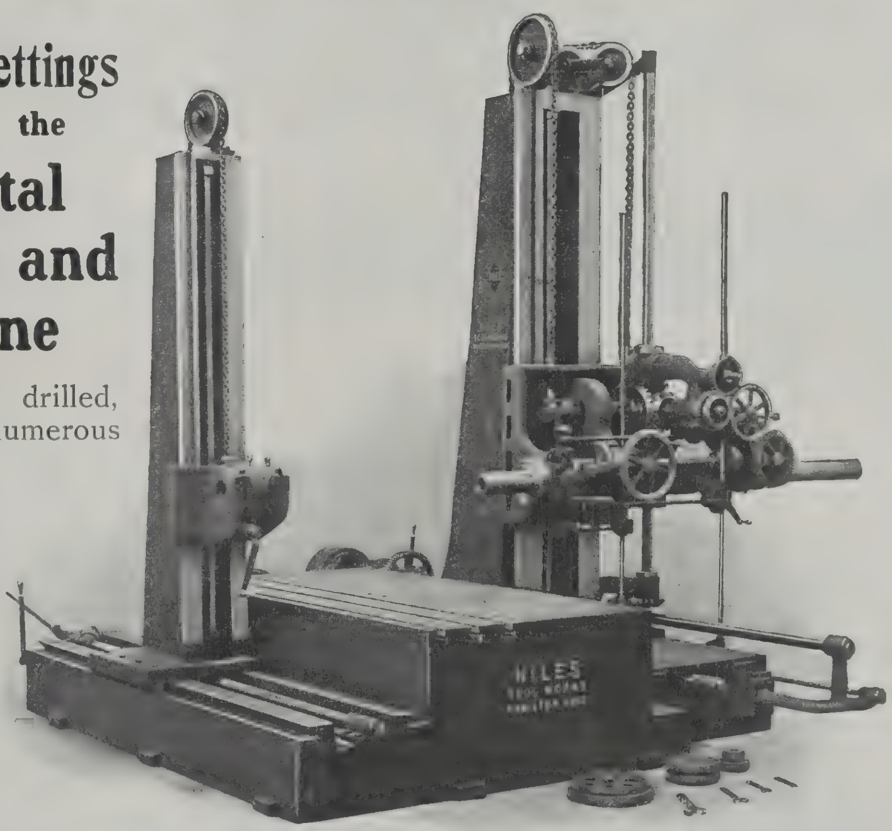
For each operation—use the

Niles Horizontal Boring, Drilling and Milling Machine

Work once set up can be drilled, bored, tapped and have milled numerous small surfaces that are scattered over a wide area, either outside or inside, without disturbing the setting.

Machine illustrated is especially valuable for machining printing press frames and work of a similar character.

Write for illustrated Circulars.



Horizontal Boring, Drilling and Milling Machine.

POND COMPANY

LONDON, 25½ VICTORIA ST., S. W.

Bement Hammers, Hydraulic Machinery

and Callowhill Sts Birmingham, Ala., Brown-Marx Bldg. Detroit, Mich., Majestic Bldg. Agents for Canada, The Canadian Fairbanks Co., Ltd.. Montreal, Arizona, Harron, Rickard & McCone, 461 Market St., San Francisco, and 164-168 N. Los Angeles
Kretschmer & Co., Frankfort, a/M. Japan, F. W. Horne, 70-C Yokohama.

BROWN ENGINEERING Co., 123 North 3rd St., Reading, Pa. Circular of the Brown ring oiling loose pulley bushing, which can be made to fit loose pulleys of iron, steel, wood or paper. It is claimed to be very economical of oil, requiring only about one-quarter as much as the ordinary loose pulley or clutch.

W. D. ALLEN MFG. Co. 151 Lake St., Chicago, Ill. Circular No. 164 of brass and iron oil and grease cups. The Gibbs automatic, Peerless, Columbia, Czar, and Western grease cups are listed; and plain brass, Pease's oil cups, Westport crankpin oil cups, Bowe's crankpin and shaft oiler, Yankee hinged lid oil cup, etc.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletin No. 4707 entitled "Gasoline Electric Plants for Lighting and Power," describing gasoline engine and generator sets of 2 to 25 kilowatts capacity, suitable for country houses, stores, small shops, and wherever small independent electric generating sets are desirable.

CRYDER & Co., Park Ave. and 63d St., New York. Circular illustrating and describing the Ronson wrench for automobile and general use. The wrench consists of four thin open-end wrenches held together by a bolt and wing nut, the combination being so arranged that all the wrenches may be used without interference.

WESTERN ELECTRIC Co., 463 West St., New York. Booklet in post-card form giving the reasons for using the No. 1317 type magneto telephone sets designed for farms, store, and factory use. The construction has been very carefully designed to eliminate weak features, provide a strong magneto and durability throughout.

HOLTZER-CABOT ELECTRIC Co., Brookline, Mass. Circular illustrating Holtzer-Cabot motors, generators and applications. These motors are built in small sizes, 1/15 to 3 horsepower. The applications illustrated include alternating- and direct-current universal drills (see MACHINERY, December, 1909) back-geared motors, motor generators, etc.

GOULD & EBERHARDT, Newark, N. J. Folder of high-duty "D. T. Q." (double triple quick) shapers illustrating the construction of the back-geared and single-geared types. The 14-inch shaper makes from 10 to 130 strokes per minute; 16-inch, 7 to 125 strokes per minute; 20-inch, 6 to 110 strokes per minute; and 24-inch, 6 to 100 strokes per minute. This indicates the wide range of speeds available.

AMERICAN BRIDGE Co., 30 Church St., New York. Diary and calendar for 1910 containing data on beams, standard framing, angles, weights of angles, Z-bars, round and square bars, standard upsets, standard clevises, sleeve nuts, etc. In addition there is general information on domestic postage, weather bureau signals, value of foreign coins in United States money, weights and measures, interest laws, brief business laws, etc.

AMERICAN ENGINE Co., Bound Brook, N. J. Pamphlet reprint from the *Electrical World*, entitled "Arrangement of Cylinders to Produce Uniform Torque," being the discussion of the angle compound steam engine lately developed by the company. The turning moment with the cylinders arranged at an angle of 90 degrees and connected to the same crank pin approximates a straight line curve, being remarkable for uniformity of torque.

INTERNATIONAL ENGINEERING Co., 1779 Broadway, New York. Catalogue of RBF radial ball bearings for lineshafts, automobiles and all purposes where anti-friction bearings are desired; also RBF thrust ball bearings for propeller shafts, step bearings, automobile wheels, steering pivots, etc. The introductory article on ball bearings with special reference to RBF bearings containing useful data will be appreciated by users of ball bearings in general.

BROWN HOISTING MACHINERY Co., Cleveland, Ohio. Pamphlet on "Ferroinclave," a reinforcement for roofs, floors, partitions sidewalks, stairs, coal-bins, tanks, etc. Ferroinclave reinforcement is sheet steel crimped by special machinery into dovetail sections, which make the application of cement on both sides easy and secure. The pamphlet is illustrated with many views, interior and exterior, showing roofs, walls, stairways, etc., that were built with the reinforcement.

GATCHEL & MANNING, Philadelphia, Pa. Circular entitled "The Blue print, the Artist, and the Halftone," advertising the company's activities in the direction of producing perspective wash drawings of machinery from blueprints. This method of producing illustrations is recommended when it is desirable to issue advertising literature simultaneously with the first machine. The manufacturer does not have to wait until he can photograph the completed machine before making his halftones.

J. E. HOPPEN & SONS, 75-79 Main St., Belleville, N. J. Catalogue of Hoppen grindstones made for foot-power and shaft driving with or without loose pulleys; also Hoppen steel grindstone arbors, self-oiling journal boxes, grindstone truing device and adjustable shaft hanger. A strong claim is made for grindstones, their abrasive power when correctly applied being second to none, the emery wheel not excepted. The peripheral speed at which grindstones should run is recommended at 1,600 to 1,800 feet per minute.

KEUFFEL & ESSER Co., Hoboken, N. J. Pocket calendar for 1910 and the solar ephemeris for 1910. The pocket calendar is on a celluloid card with rounded corners convenient for carrying. The solar ephemeris (tables used by surveyors, mariners, explorers, etc.) gives the sun's apparent declination, difference for one hour, the sun's semi-diameter, time to be added or subtracted from apparent time, for each day of the year; also tables of mean refraction correction and sun's parallax in altitude. Sent free on application.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J. Booklet entitled "Graphite as a Lubricant," being a treatise on the theory and practice of graphite lubrication, eleventh edition. It describes the requirements of a lubricant, the advantages of flake graphite, and the use of graphite lubrication. A portion of the book is devoted to the scientific investigations of graphite made by Prof. W. F. M. Goss while Dean of the College of Engineering, Purdue University. The treatise will be interesting and useful to the users of machinery who are not satisfied with their present means of lubrication.

NORTON Co., Worcester, Mass. Catalogue of grinding products comprising alundum, grinding wheels, grinding machinery, glass cutting wheels, India oil-stones, razor hones, scythe stones, rubbing and sharpening stones, etc. The catalogue contains a treatise on alundum and illustrates departments in the factory showing the process of the manufacture of alundum wheels. A large variety of wheel shapes are listed with diagrams showing dimensions, these being grouped according to class or use, making the selection of wheels convenient. The catalogue is one of the highest grade trade publications that comes to our desk.

I. SHONBERG, 363 Hudson Ave., Brooklyn, New York. Booklet on metals giving successful formulas for toning linotype, stereotype, compositype, and monotype metals, linotype formulas for newspaper, book and job work, compositype formulas, electrotype, monotype, stereotype formulas. Six formulas for babbitt metals for various purposes are included, also die casting alloys and the constituents of britannia, bronze, German silver, etc. The compiler is the maker of Shonberg's Diamond S. M. N. metal used on bearings in automobiles, wood pulp machinery, paper mill machinery, steamships, locomotives, dynamos, etc.

GARVIN MACHINE Co., Spring and Varick Sts., New York. Catalogue G, illustrating and describing spring coiling machines in four sizes, cutter and surface grinders, screw slotting machines, milling machine attachments comprising dividing heads, indexing circles, multiple spindle index centers, automatic index milling machine, slide rests, arbors, vertical milling attachment, cam cutting attachment, vertical spindle attachment, milling cutters, worm milling attachment, oval or elliptical chuck, box tools, knurling tools, automatic turrets, friction pulleys, countershafts, hand and speed lathes. Directions for spiral setting on the Garvin universal milling machine and other useful information and tables are included.

B. F. STURTEVANT Co., Hyde Park, Mass. Catalogue No. 150 of Sturtevant fuel economizers and air heaters. The working principle is described, and figures indicating savings effected are given. The Sturtevant high-pressure type economizer is described. In this type, all joints are metal-to-metal and will stand a pressure up to 300 pounds per square inch. It has the Sturtevant scraper mechanism in which the scraper cannot stick or bind, thus eliminating one of the troubles experienced with the earlier types of economizers. Tables of sizes are included, also tables of saving of fuels, properties of saturated steam, percentage of savings per degree increase in feed water, percentage of savings effected by heating feed water from initial to final temperature, etc.

BARDONS & OLIVER, Cleveland, Ohio. Catalogue of turret machinery comprising turret lathes with oil pan and oil pump for bar forging and casting work; turret lathes without oil pan, mounted on legs for brass and other materials not requiring the use of a lubricant; parts and attachments for turret lathes; tools for turret lathes, etc. The catalogue has been prepared with much care and is subdivided into parts. Part V comprises illustrations and names of machine parts. Part VI is given up to reference tables comprising speeds of machines, standard gear tooth parts, tapers per foot and corresponding angles, comparison of threads, machine screw dimensions, wire gages, worms and worm gearing, weights and measures, etc. Users of turret machinery will find this catalogue of general interest and value.

H. W. JOHNS-MANVILLE Co., 100 William St., New York. Folder advertising Johns-Manville asbesto sponge felted sectional pipe covering for high pressure and superheated steam pipes; asbesto fire felt sectional pipe coverings for the same purpose; magnesia sectional pipe coverings; "asbestocel" sponge pipe covers for medium and low pressure steam and hot water. It is claimed that there is a great difference in the efficiency of pipe coverings. A plant is illustrated which, when the pipes were equipped with "ordinary" pipe covering, used five cars of coal per month. The pipes in the same plant were afterwards covered with asbesto sponge felted coverings and the coal consumed was reduced to four cars per month. How much of the saving was due to other improvements in equipment and management is not recorded.

DAVIS-BOURNONVILLE Co., 97 West St., New York. List of recent interesting operations performed with the company's oxy-acetylene welding and cutting torch as follows: Welding galvanized iron tank instead of riveting; welding Fenestra steel window sash, formerly brazed; welding broken strands of expanded metal used in concrete reinforcements (The strands of metal frequently break when the sheets are expanded after perforation, and it is customary when five or six breaks occur to scrap the sheet; these broken strands are now welded at the rate of thirty per hour); welding bed plate of a six-inch cylinder gas engine; cutting off sink heads of steel castings, 2½ by 4 inches, in forty seconds; quick repairs to Hawley down draft boiler headers; welding a cracked locomotive bell; repairing a large Corliss engine (broken cast-iron arms were welded, about 8 inches wide by 3 inches thick). The factory driven by the engine employed 600 men. The repair was quickly made and but little time was lost.

WESTINGHOUSE ELECTRIC & MFG. Co., Pittsburg, Pa. Westinghouse Diary for 1910. This diary has been issued annually for the past six years and new matter is introduced into each edition, the general character of which pertains to electrical generators, transmission of power, electric lighting, etc. It contains much valuable data and the size, 2¾ by 5½ inches, makes it convenient to carry in the pocket. The following is a partial list of contents: Westinghouse air compressors, comparison of aluminum with copper, armature resistance, motor control, horsepower of belting, cooling water for condensing, operating gas engines, population of cities, electric railway energy consumption, electric heating apparatus, steam engine horsepower formula, heating value of fuels, Le Blanc condensor, direct-current locomotives, strength of materials, efficiency horsepower, postal information, resistance of metals, steam turbine data, storage battery data, thermal expansion of metals, Westinghouse tungsten lamps, formula for horsepower of water flow, how to remember the wire table, etc.

TRADE NOTES

AL-ED MFG. Co., Dayton, Ohio, has been organized to build bench millers, drills, etc.

BURKE MACHINERY Co., 1837 35th St., Cleveland, Ohio, has moved to Conneaut, Ohio.

COLTON COMBINATION TOOL Co. has moved from East Hampton, Mass., to Chester, Vt., and has been reorganized.

MILLET BRASS Co., Springfield, Mass., maker of brass and aluminum goods and the Millet core ovens, is building a new factory and office structure.

NORTHERN ENGINEERING WORKS, Detroit, Mich., builder of northern cranes, has purchased additional land adjoining its plant on which it will build an extension of its crane department.

BAY STATE SCREW Co., maker of screw machine products and metal specialties, has moved from Springfield, Mass., to Hatfield, Mass., and has increased its manufacturing capacity threefold.

TOLEDO ELECTRIC WELDER Co., Cincinnati, Ohio. Catalogue of electric welding machines made in a large variety of styles and sizes adapted for a great variety of manufacture.

CLEVELAND TWIST DRILL Co., Cleveland, Ohio, announces that F. F. Prentiss has resigned from the presidency of the company on account of ill health, and is succeeded by J. D. Cox, formerly vice-president.

BRUCE-MACBETH ENGINE Co., Cleveland, Ohio, builder of two- and four-cylinder vertical gas engines, has opened a branch office at 1020 Drexel Building, Philadelphia, Pa. The office will be in charge of Mr. M. E. Jackson.

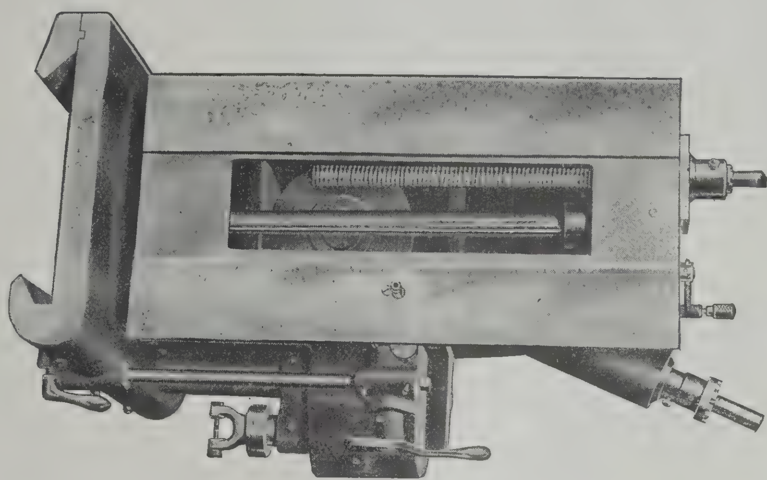
CONANT & DONELSON Co., manufacturer of taps and dies, has moved from Greenfield to Conway, Mass., where a building has recently been built. There is a water power and electric light plant in the main building and a separate building for the heating plant.

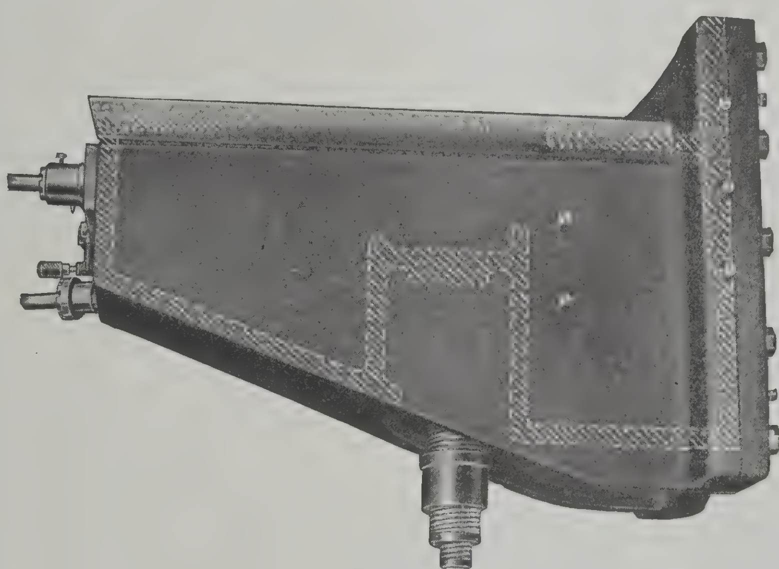
NEW YORK LEATHER BELTING Co., 51 Beekman St., New York, has enlarged the size of its house-organ *Phoenix* to 9 x 12 inches. It contains 16 pages, including the cover, and is filled with interesting and practical matter on belting, belting applications, the belting trade, etc.

W. N. BEST AMERICAN CALORIFIC Co., 11 Broadway, New York, has retired from business. Mr. W. N. Best will personally manufacture and sell the oil and tar burners, regulating cocks, and various types of furnaces of which he is the inventor. He will continue his office at 11 Broadway.

Cincinnati High Power Miller Rigidity

The knee of a Miller is subjected principally to twisting strains due to the pressure of the cutter against the work, tending to overturn the table and saddle.





Cincinnati High Power Miller Knees are designed to resist these twisting strains. The cuts show the webbing. They are reinforced boxes, and a box will resist twisting better than any other rectangular structure.

Prove this to yourself.

Take a light box, complete with lid fastened down and note its torsional stiffness compared with a box of the same size that has no bottom and only one end made of boards twice as thick.

The complete box will win.

This is the principle on which our machines are designed throughout.

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.
AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.

CONTENTS FOR FEBRUARY

CUTLER-HAMMER MFG. CO., Milwaukee, Wis., has just completed a new factory in New York. The building is on Southern Boulevard at 144th St. and Timpson Place. It is five stories high and contains about 100,000 square feet of floor space. It is of steel and brick construction throughout.

LANDAU & GOLDEN, 1779 Broadway, New York, consulting engineers, have added an associate and western engineer, Mr. Oscar Stegeman, to their firm. Mr. Stegeman will be located in Milwaukee, Wis. In addition to their regular consulting work, the firm will also make physical and chemical tests of materials.

CLING SURFACE CO., Buffalo, N. Y., reports that a rope drive installed in the Paramatta Woolen Mills, Sidney, N. S. W., in which the rope is treated with "Cling Surface" runs so slack that the top ropes hang in loops below the bottom ropes, which are in tension. An advantage of the use of the compound is that it makes shortening the ropes and re-splicing them seldom necessary.

HESS-BRIGHT MFG. CO., 21st and Fairmount Ave., Philadelphia, Pa., states that profiling lathes, copying lathes, shoe-last lathes, etc., used for the manufacture of stair rods, newel posts, spools, knobs, axe handles, shoe lasts, wheel spokes, etc., are now being built with spindles mounted on Hess-Bright ball bearings. The builders of this class of machinery have generally discarded plain journals.

BARNES DRILL CO., Rockford, Ill., has acquired five acres between Elm and Cedar Sts., on Kent Creek, Rockford, on which it will erect a plant for its business of manufacturing upright drills and lathes. The first structure to be erected will cover about one-half acre. It will be built of reinforced concrete, and will be absolutely fireproof. Probably two buildings will be erected during the present year.

SELIG, SONNENTHAL & CO., 83-85 Queen Victoria St., and Lambeth Hill, London, England, for family reasons has formed a private limited liability company under the title of Selson Engineering Co., Ltd. All the assets and liabilities of Selig, Sonnenthal & Co., London, and Selson Machine Tool Works, Coventry, have been taken over by the new company, and the business will be carried on exactly as before and under the same management.

DEWSTOE-LATHROP MACHINERY CO., Birmingham, Ala., is a machinery selling organization, lately formed by the association of Messrs. W. R. Lathrop and M. E. Dewstoe. The company does an exclusive machine tool business in Tennessee, Alabama, Georgia, and Florida. Mr. Lathrop was formerly connected with the Niles-Bement-Pond Co.'s New York and Birmingham offices, and Mr. Dewstoe has been in the machine tool business in the south for eight years.

A. E. QUINT, Hartford, Conn. Catalogue of Quint's vertical drilling, tapping and chucking machines. All spindles are driven from a common center and only the spindle in use rotates. These machines are made in a variety of styles and sizes ranging from 32 inches, six spindles, to 20-inch 12 spindles. They are adapted for manufacturing where many holes of varied sizes must be drilled in a single piece and the holes tapped, counterbored and reamed.

BUFFALO TOOL & SUPPLY CO., Buffalo, N. Y., was recently incorporated for the purpose of buying and selling machinery and accessories. The incorporators are A. B. Kellog and Charles Park of Buffalo and Myron Grinell, Waymart, Pa. Mr. Charles Hood, for many years connected with the Buffalo Tool & Machinery Co., will act as manager. The concern is desirous of receiving catalogues and prices to dealers on various makes of machinery in the wood-working line.

SKINNER CHUCK CO., New Britain, Conn., gave a banquet to its employes at the New Britain Club December 28 which was attended by every male employe of the company, something over ninety in all, with the exception of D. N. Camp, president, who was unable to be present on account of ill health. E. J. Skinner, secretary of the company, acted as toastmaster. The company believes that all its workmen are factors in its success and treats them as members of one big family.

WATSON-STILLMAN CO., 192 Fulton St., New York, has made several additions to its sales department to handle its increasing business in hydraulic tools and turbine pumps. Edwin Stillman has entered the sales department and is assisting in taking care of customers in New York state. All southern railroad business is now in charge of Frank C. Clark. The more direct representation that has become necessary in the Orient will be in the hands of F. W. Horn, the well-known machinery importer of Yokohama, Japan.

DODGE MFG. CO., Mishawaka, Ind., has established new stores in Minneapolis, Minn., and Atlanta, Ga. The Minneapolis store is at 202-204 Third St., S., and the warehouse at 312 First St., N. The agency arrangement with the Minneapolis Steel Co. has been discontinued. Burke Richards, formerly resident salesman at Cleveland, Ohio, has been promoted to manager of the Minneapolis store. The Atlanta store and warehouse is at 54 Marietta St., Atlanta. S. L. Dickey, resident salesman, is manager.

MILLIKEN BROS., INC., Milliken, Staten Island, N. Y., which placed its affairs temporarily under the protection of the Federal courts in June, 1907, has been released from the receivership, and the entire plant and all its assets has been restored to the company The new officers and board of directors, who have taken immediate control, are Edward C. Wallace, president; Gilbert G. Thomas, Gates W. McCarrah, A. A. Fowler, Clarence N. Lewis, William Parsons, C. H. Zehender, directors, and Francis Dykes, general manager.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., calls the attention of railroad men to its graphite engine front finish as being superior to the ordinary "dopes" that are commonly used. These are defective in that they require frequent renewal, which means not only extra cost of material but cost of labor as well. Some of the material is volatile, and on becoming hot offensive fumes are driven back into the cab. The graphite front-end finish is said to give service of from six to nine weeks for each application. It makes a durable and attractive coating, not affected by heat or cold.

INTERNATIONAL STEEL TIE CO., Altoona, Pa., held its first annual meeting of stockholders in Altoona and voted to sell $50,000 worth of stock for the purpose of establishing the manufacturing plants necessary for the filling of the orders for steel ties now on the books. V. A. Oswald, J. R. Boeckel, William P. Day, of Altoona; J. P. O'Donnell and P. H. Lavin of Cleveland; and Harry Emmons of Delaware, were elected directors. V. A. Oswald was elected president; George Harpham, vice-president; S. M. Hoyer, secretary; and W. P. Day, manager.

WESTERN ELECTRIC CO., 463 West St., New York, reports that its gross earnings for the year of 1909 were $46,000,000, being an increase of $13,000,000 over the year of 1908. The increase for 1909 is distributed over the various lines of manufacture, these being telephone apparatus and telephone cables. The company employs at present approximately 17,000 people. During the year more of the manufacturing business has been concentrated at Hawthorn, Ill., and new buildings have been erected to take care of the increase. The total earnings for the past ten years are $384,000,000.

CHICAGO BEARING METAL CO., 45th St. and Center Ave., Chicago, Ill., announces that its new plant is now in operation, and that it is ready to fill orders for journal bearings, locomotive bearings, manganese castings, steam metal castings, automobile castings, premium babbitt metal, phosphor-copper, manganese copper, hydraulic bronze, anti-acid bronze, solder, etc. Upon request, the company will submit a form of contract covering any firm's requirements in its line at a fixed price for six months or a year. Its new plant is one of the most modern and complete in the country. It is admirably located and has first-class shipping facilities.

CAMERON ENGINEERING CO., 156 Berriman St., Brooklyn, N. Y., recently made Mr. F. A. Hall its vice-president and treasurer following his resignation as manager of the hoist department of the Yale & Towne Mfg. Co. The company was started by Ewan Cameron and Murde MacDonald as a working partnership about twelve years ago. The business was afterward incorporated and the plant enlarged. Mr. Hall, who began with the Yale & Towne Mfg. Co. over twenty years ago as tool-maker and draftsman and was promoted to engineer of the light cranes and over-head track work in 1890, will devote himself to the standardizing of the devices for over-head transportation and conveying of working materials invented by Mr. Cameron.

C. H. CATON & CO., Ltd., Keighley, England, has acquired the works of Samuel Lund & Sons and the engineering businesses incorporated therewith. It also has acquired the drawings, patterns, etc., which were formerly the property of John Dikenson & Co., Milley's Machine Co., F. & J. Butterworth Co., and Low Moor Iron Co. (machine tool department). The plant has recently been brought entirely up to date and the most advanced methods of accurate production installed. A rigid system of inspection has been incorporated and advantage has been taken of the new steels for parts subject to great stresses. The company is prepared to build special machines and to work up inventions in a practical manner.

TOLEDO ELECTRIC WELDER CO., formerly of Toledo, Ohio, has increased its capital stock from $30,000 to $75,000, and moved to Cincinnati, Ohio, where it has made a long lease of a two-story modern brick factory building 160 feet by 60 feet. A fine equipment of machine tools has been installed and the building was in full operation February 1 manufacturing a full line of electric welding machines. The officers are Neil Macneale, president and treasurer; Walter G. Franz, vice-president; Frank Warren, secretary and general manager. These, with G. W. Drach and J. A. Muir, are the directors of the company. Nearly all of the Toledo employes moved to Cincinnati, so that the personnel of the operating force will be the same as heretofore.

SUPERIOR MACHINE TOOL CO., Kokomo, Ind., manufacturer of upright drills, is now occupying its new factory, which is a modern up-to-date building about 400 feet by 100 feet and equipped with all up-to-date tools and devices. Alfred Weigl, the general manager, was for many years at the head of the Aurora Tool Works, Aurora, Ind., and has equipped the Kokomo plant not only from his own experience, but also from the results of an extensive study of drill manufacture in other plants. Plans have already been made for the addition of a wing to the present building, to be 400 feet by 100 feet, and also for a large foundry. It is the intention of the concern to become the largest manufacturer of popular-priced drill presses in the world.

DIAMOND CHAIN & MFG. CO., Indianapolis, Ind., recently supplied machine-cut chain and sprockets to the William Tod Co., Youngstown, Ohio, builders of large rolling mill engines, for the governor drive for the largest tandem compound engine ever built (52 x 90 x 60 inches). This engine was made to run a 43-inch, three-high blooming mill in the Youngstown works of the Carnegie Steel Co. It is rated

Showing case open and drawers exposed.

A MACHINISTS' PORTABLE TOOL CASE

EVERY INCH OF SPACE IS USABLE!

Solid oak (except bottoms and sides of drawers) corners all dovetailed; drawers run on hardwood slides and have brass knobs; brass spring lock and two flat steel keys, comfortable leather carrying handle. Outside dimensions 15⅝ x 8 x 10¾ in., net weight 16 lbs., boxed for shipment about 30 lbs. Properly made, highly finished.

$10.00 EACH NET, F. O. B. NEW YORK.

If more information is wanted, ask for Circular No. 2752.

HAMMACHER, SCHLEMMER & CO.

Hardware, Tools and Supplies

4th Ave. and 13th St. **NEW YORK, SINCE 1848**

Showing case closed and locked.

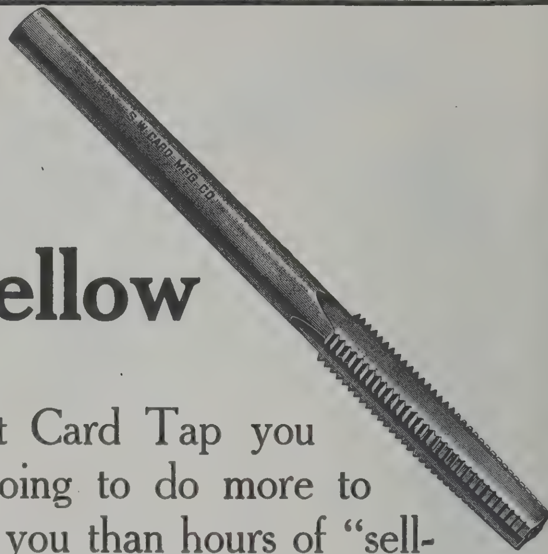
at 4,000 horsepower, but delivers a peak load of 15,000 horsepower through the accumulated energy in the twenty-four-foot fly-wheel, weighing 120 tons. The chain has been found to be the only drive that insures close governing and absolute dependability. The chain supplied is the standard roller type similar to that used in automobile service.

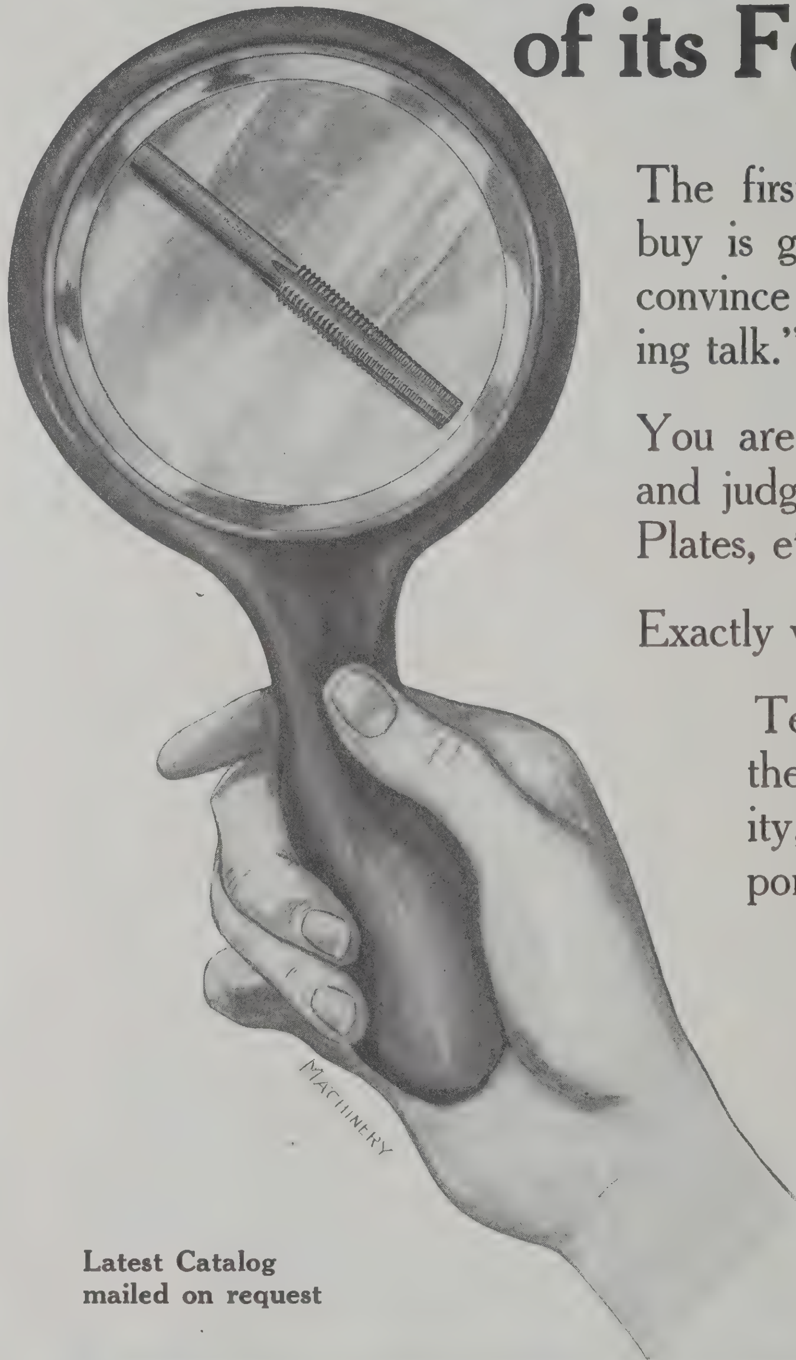
CHICAGO BEARING METAL CO., 400 Old Colony Building, Chicago, Ill., has been incorporated for the manufacture of locomotive and engine castings, journal bearings, automobile castings, brass and bronze castings, babbitt metal, alloys, etc. The president is C. A. Bickett; and general sales agent, Walter D. La Parle. Mr. La Parle, who is a native of Chicago, has been in the railway supply business for the past twenty years. He has an extensive acquaintance among railroad officials and the operating, maintenance-of-way and mechanical departments. He was for eleven years connected with the Verona Tool Works of Pittsburg and was the organizer of the Solid Steel Tool Co., now the Western Tool & Forge Co., of Brackenridge, Pa. The works of the Chicago Bearing Metal Co. are located at 45th and Center Ave., Chicago, where ample railroad facilities are available. The main building is 210 feet long and 150 feet wide. The pattern storage, cinder grinder and fuel storage plant is a concrete fire-proof structure. Everything is new and up-to-date and the building, equipment, arrangements, and methods of handling the product are the equal of if not superior to any similar plant in the country.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

Each Card Tap is a Reflection of its Fellow





The first Card Tap you buy is going to do more to convince you than hours of "selling talk."

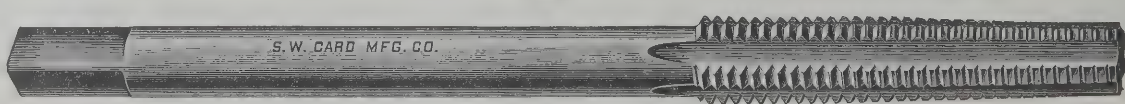
You are going to test that first Tap and judge all our Taps, Dies, Screw Plates, etc., by its performance.

Exactly what we want you to do.

Test the Tap—test it with all the others—we know its quality, perfect temper, correct proportion, design, accuracy, clean cutting and lasting efficiency—and one Card Tap is the reflection of all the rest.

If you have threads to cut—Card's are the tools to make thread cutting easy.

Latest Catalog mailed on request



S. W. CARD MANUFACTURING COMPANY

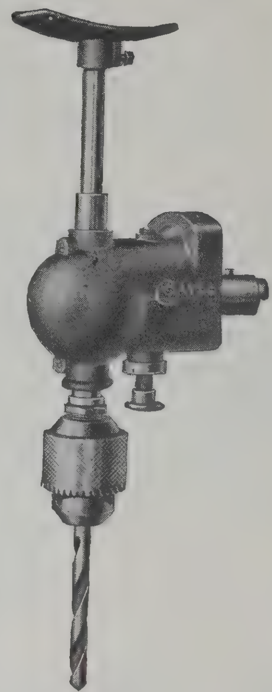
MANSFIELD, MASS., U. S. A.

EUROPEAN AGENTS—Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow; Markt & Co., Ltd., Paris; Fenwick Freres & Co., Milan; Ignacz Szekely, Budapest; V. Lowener, Stockholm, Copenhagen, Christiania; A. A. Kampfraath (Brussels), Ltd., Brussels; Hans Schulze, Brunn, Austria.

COATES Are Economy

Until you put a Coates into your shop you won't believe the amount of time it will save and how much unnecessary labor will be eliminated.

There is practical saving all along the line with a Coates. Portable tools mean a lot in the day's work.



Breast Drill, Style D.

Flexible Shafts Workmen

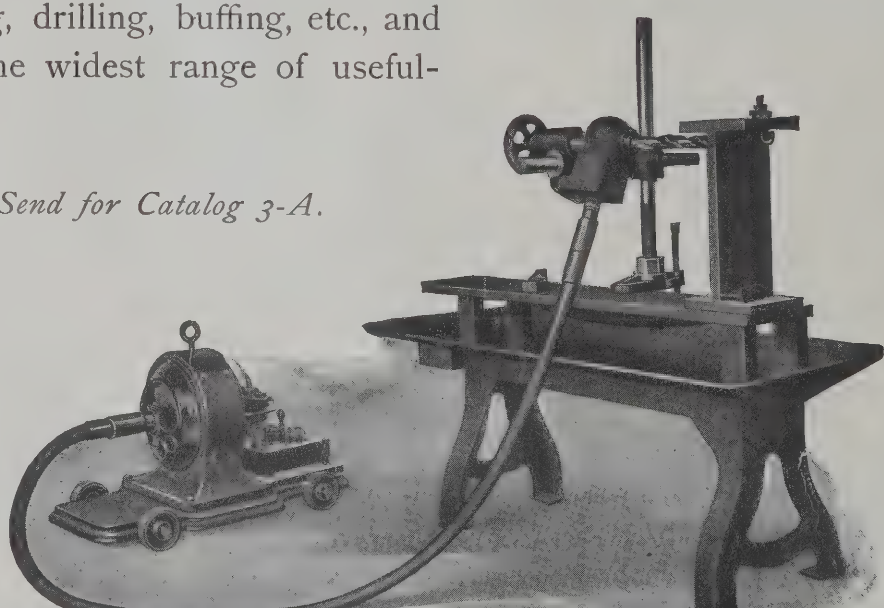
Style D, Breast Drill used in connection with the Coates Flexible Shaft Outfit gives you a first class working tool that will cut time and drill holes simultaneously.

A changeable speed drill, built after the fashion of an automobile transmission, allowing the proper speeds for the various sized drills for which it is designed.

Outfit No. 10, is another good one. It's a 1 H. P. motor mounted on truck with a variable speed drill press, press holder and old man, connected with a Coates Standard No. 44 Flexible Shaft. Capacity up to 1¼" holes, an ideal motor drilling outfit.

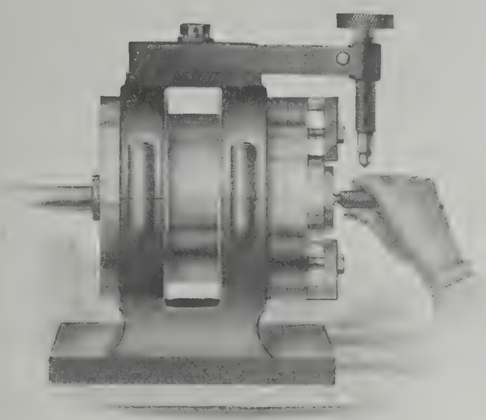
All Coates equipments are of the practical and serviceable kind. Tools are interchangeable for grinding, drilling, buffing, etc., and cover the widest range of usefulness.

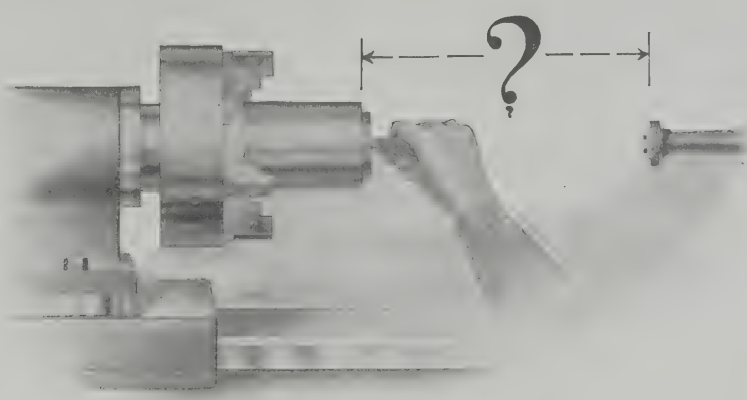
Send for Catalog 3-A.



Outfit No. 10, capacity 1¼" hole.

COATES CLIPPER MANUFACTURING CO.
WORCESTER, MASS., U. S. A.

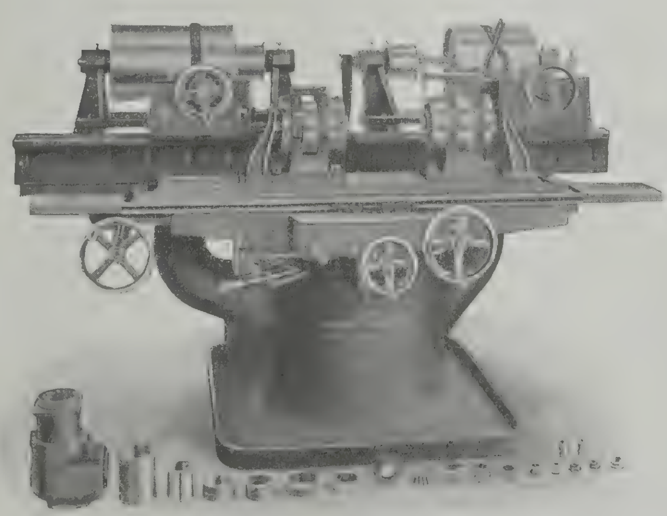




The Bath Way—or the Old Way?

THERE'S no time lost with the Bath Duplex Internal Grinder—when you begin to grind, it's a steady grind to a finish. The Bath method has not only solved the problem of accurate and economical internal grinding, but it has shortened the time required, reduced the labor, and cut out unnecessary movements of the operator that heretofore were considered essential to the work.

In the Bath Machine the grinding wheel enters the hole from the back end, grinding begins from the front end as usual, but the grinding wheel is always in the hole. Work can be gauged without a minute's loss of time—no backing out of grinding spindle, gauging, readjusting, starting up again—all the endless and unnecessary bother done away with.



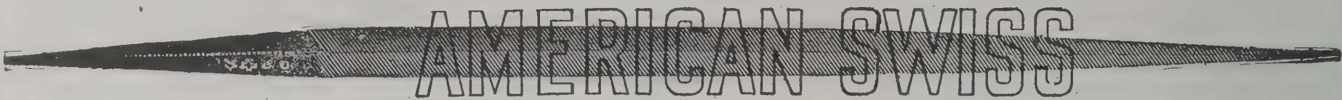
The **Bath Internal Grinder** covers all classes of internal grinding, spindles are so mounted that all spring and vibration is overcome, and two pieces of work or two diameters in the same piece can be ground simultaneously. There is much of interest in the Bath outfit, and a practical value that leads to profit.

May we send you a Catalogue?

THE BATH GRINDER CO., Fitchburg, Mass.

FOREIGN AGENTS—Japan, Alfred Herbert, 224 Yamashito-cha, Yokohama. Northern and Eastern Germany and Austria-Hungary, Heinrich Dreyer, Kaiser Wilhelmstr. 1, Berlin. Western and Southern Germany, Switzerland, Holland, Belgium, France, Spain and Italy, Alfred H. Schutte, Neumarkt 18, Cologne.

The Files for discriminating users—for the Toolmaker, the Machinist, for all Skilled Workers



A Word about Discounts

A Suggestion and a Note of Warning.

Anybody can cut prices—that's easy—but not everybody can produce the goods. Price and Quality must go to market together, or *Quality* will die a natural death, which applies to discounts and should be borne in mind especially when ordering Files.

Samples sent free on request. Write on business letter-head and state size, shape and cut preferred.

American Swiss File and Tool Company, 24 John Street, New York

DISTRIBUTORS:

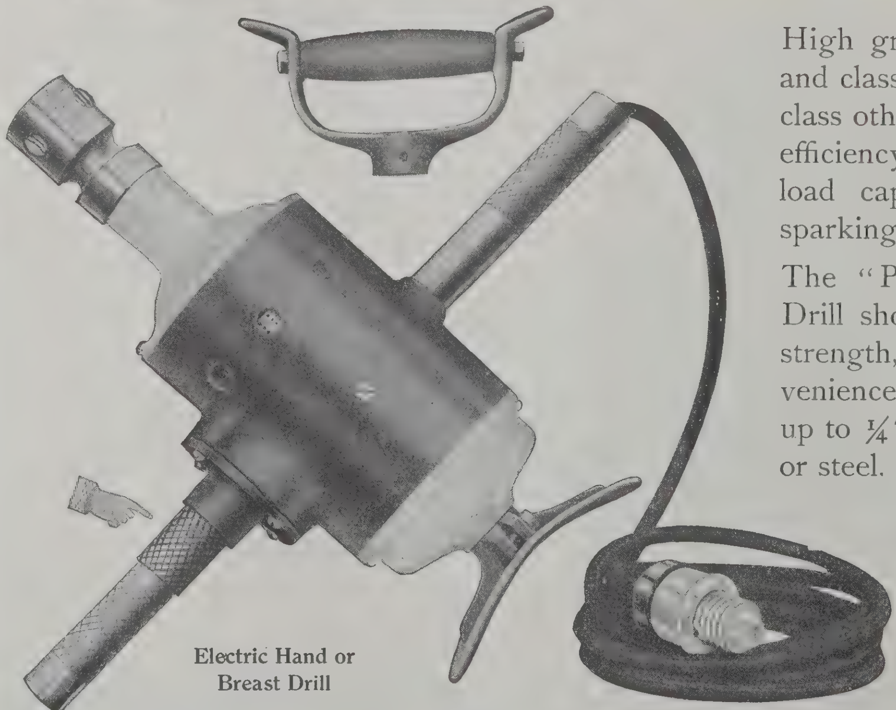
E. P. REICHHELM & CO., 24 John St., New York.
THE MACHINISTS' SUPPLY CO., 324 Third Ave., Pittsburg, Pa.
THE BOYER-CAMPBELL CO., 64 Congress St., Detroit, Mich.

DUCOMMUN HARDWARE CO., 300 No. Main St., Los Angeles, Cal.
THE MACHINISTS' SUPPLY CO., 119 No. Canal St., Chicago, Ill.

CHANDLER & FARQUHAR CO., 34 Federal St., Boston, Mass.
WHITE TOOL & SUPPLY CO., 1313 Sixth St., N. W., Cleveland, O.
TRACY, ROBINSON & WILLIAMS CO., Hartford, Conn.

The Peerless Electric Drills

TRADE MARK



Electric Hand or Breast Drill

High grade in design, construction and class of work produced. Outclass other electric portable tools in efficiency, wearing qualities, overload capacity and freedom from sparking.

The "Peerless" Hand or Breast Drill shown, has the advantage of strength, portability, speed and convenience in operation and will drill up to ¼", ⅜" or ½" holes in iron or steel.

"Peerless" Electric Portable Drills are made in ten sizes—are air cooled and arranged for direct or alternating current.

THE CINCINNATI ELECTRICAL TOOL COMPANY, Cincinnati, Ohio

An Ideal Steel for Lathe Tools—

for finishing Cuts—Turret Tools and Cutting Tools of all kinds

Coming between high speed steel and carbon steel, and partaking of the nature of both, INTRA Steel has a place of its own.

It gives you strength and immense cutting power, toughness for hard service and long wear, and at the same time maintains a fine cutting edge far beyond the average.

It has from three to five times the cutting power of carbon steel.

Will not shrink in hardening.

Is adapted for usual and unusual purposes—and is sold at a very moderate price.

Manufacturers of taps, reamers, dies—small tools in general—will find INTRA Steel an able ally. Give it a trial.

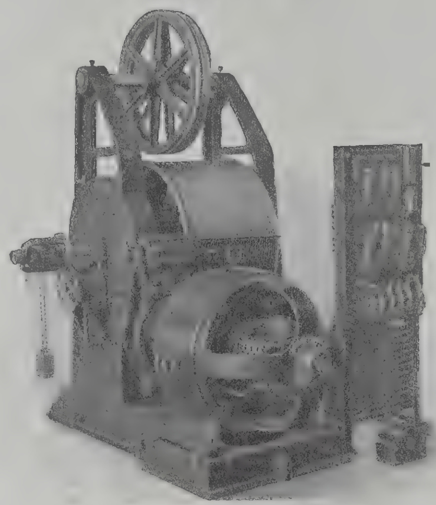
HERMANN BOKER & CO.

101-103 DUANE STREET, NEW YORK CITY

Chicago Warehouse, 217-223 N. Desplaines St. Montreal, Canada, Warehouse, 332 St. James St.

Pacific Coast Agents, Pacific Tool & Supply Co., San Francisco, Cal.

A C-W Motor for Every Service



Form I motor driving Haughton Elevator Machinery.

Elevators are only one of the many classes of machines equipped economically with **C-W** motors.

Bulletin 100-R describes the motor shown above.

CROCKER-WHEELER COMPANY
MOTOR-DRIVE EXPERT
AMPERE, NEW JERSEY

Fast Riveting

Requires a High Speed Tool

OUR

Ball Bearing Tool

USED IN

The National Riveting Machine

reduces friction to a minimum and is especially adapted to continuous service.

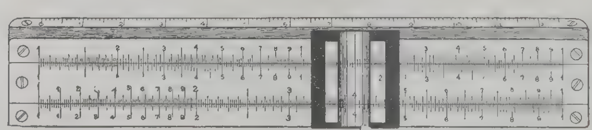
Minutes and Seconds count in a Day's Output when it only requires **One Second** to put a polished head on a rivet with the

NATIONAL RIVETER.

Riveting Reduced to a Manufacturing Basis.

The Cincinnati Pulley Machinery Co., Cincinnati, O., U. S. A.

A "MIDGET" Slide Rule



Is "VEST POCKET" Accuracy

5½" long, 1" wide, 5-16" thick, weighs 1½ ounces. A convenient, compact Slide Rule ranking in accuracy with the 10" "Precision."

Divisions easily read through powerful glass provided. No variation. Finely finished, engine divided. *Circular No. 19 for the asking.*

KOLESCH & CO.,
138 FULTON ST., NEW YORK CITY

It Is Shop Economy

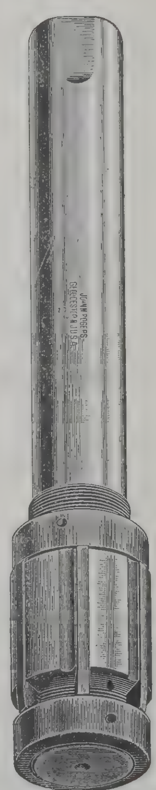
to have a **Cut-Meter** for every machine tool. With this device at hand there is no excuse for speeds below the standard. It is simple, requires no timing or calculation; adaptable, can be used on any machine; convenient, can be held in any position—and shows the operator instantly and exactly, the cutting speed in feet per minute at which his machine is running.

Built for hard service and will save its cost a hundred times over in a year.

Send for catalogue.

Warner Instrument Company
56-59 Roosevelt Avenue, BELOIT, WIS.
1781 Broadway, New York. 143 Federal Street, Boston.

SOLID REAMERS



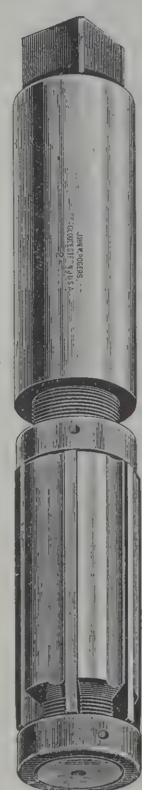
are of no practical value for accurate work after finishing a few holes so

Adjustable Reamers

are a real necessity.

The shanks are ground to serve as a limit gauge so holes smaller than standard cannot be made. Interchangeable blades of finest tool steel.

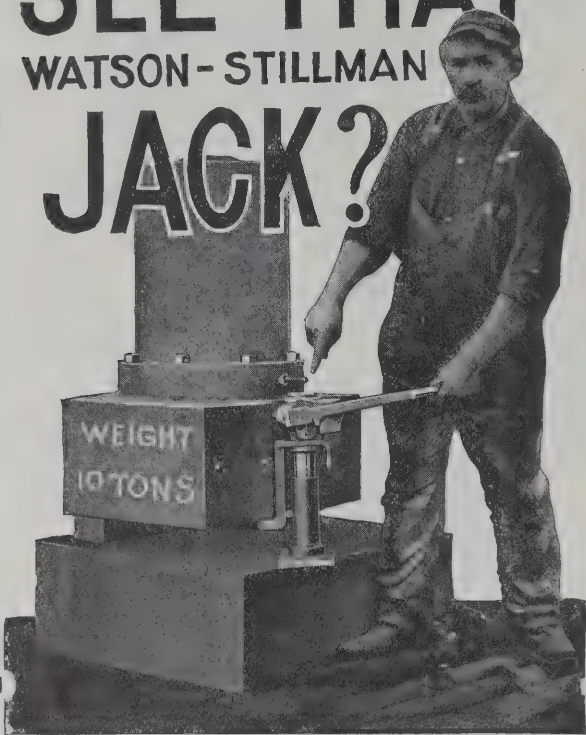
Ask for Small Tool Catalogue No. 7 and High Speed Reamer list.



THE JOHN M. ROGERS WORKS
GLOUCESTER CITY, N. J.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, E. C. Selig, Sonnenthal & Co., London, E. C. C. W. Burton, Griffiths & Co., London, E. C. De Fries & Co., Dusseldorf, Germany. V. Lowener, Copenhagen, Denmark. J. E. Chabert & Co., Paris, France.

SEE THAT WATSON-STILLMAN JACK?



HERE is just what your shop and erecting men are looking for---a light small jack, one that is easy to carry around, one that goes into small space in a tool kit, but is powerful enough to handle heavy loads safely.

A pair of these jacks affords the best means of lifting a heavy machine tool or piece of power plant apparatus for 2, 3, or 4 inch blocking or for setting on foundations, etc.

Our smallest jack of this type is only 13 inches long, but will boost a load of 7 tons through a 5 inch rise in no time. The load may be placed on the head or on the claw, it may be lifted, lowered, or pushed at an angle or horizontally. No matter what the position, the jack is convenient to operate, capable of fine adjustment and dependable. The swivel claw can be turned at any angle to the operating lever, and will go under a load that is very close to the ground.

The swivel claw type is only one of many made by us. Our line includes more than 450 types and sizes. Tell us what you expect to use jacks for and we will suggest something suitable for your work.

We also make Hydraulic Presses, Punches, Accumulators, Benders, Shears, Pumps, Valves, Fittings, etc.

W-S HYDRAULIC
TRADE-MARK

Write for catalogs.

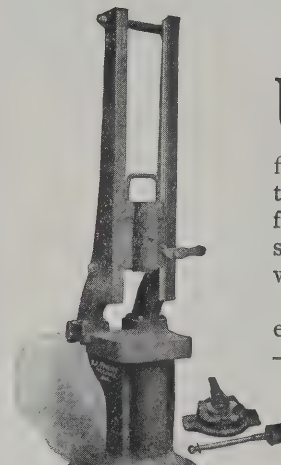
The Watson-Stillman Co.
192 Fulton Street, New York

35

SWAINE PRESSES

Throat Types

No. 2-A DROP



UNEXCELLED for bending and straightening malleable castings, also for flattening and embossing. Used to a large extent where a powerful blow is required, on work such as medals, checks, hardware, etc.

The base and uprights are extra heavy and accurately made—steel eye cast in hammer.

MADE IN TWO STYLES
—TWENTY SIZES.

Catalog on request.

Largest press builders in the West.

THE FRED J. SWAINE MFG. CO.
7th & O'Fallon Sts. St. Louis, Mo.

The Unique Construction of the

New CELFOR Drills

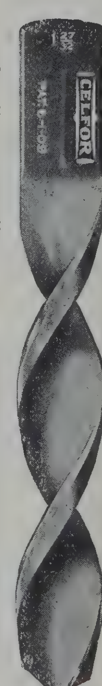
Taper Shank

makes them nearly twice as strong as a milled drill of the same diameter.

The process of twisting while hot produces an exceedingly tough tool, not easily broken and adapted for severe service.

The finished Celfor Drill is 47% stronger than the flat bar of high speed steel from which it is made.

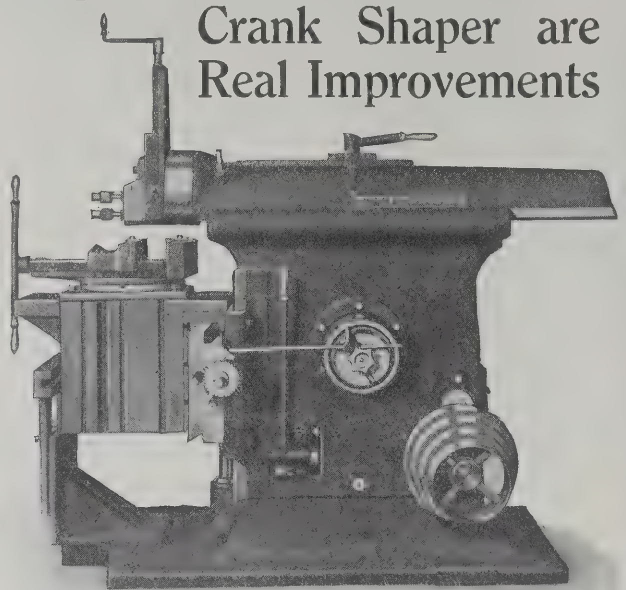
Our latest catalogue goes into details—may we send it?



Celfor Shank

CELFOR TOOL COMPANY
BUCHANAN, MICH.

Improvements on the Kelly Crank Shaper are Real Improvements

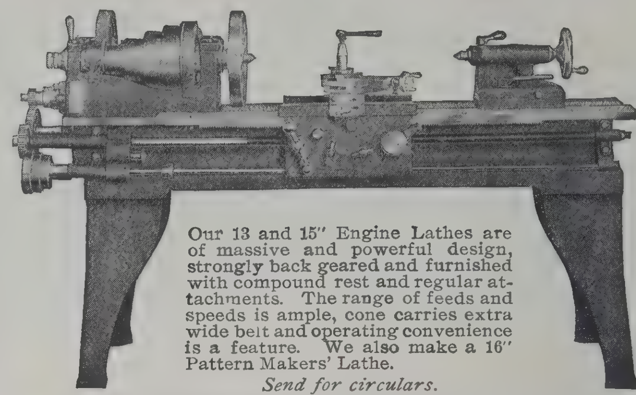


The strength and stiffness of the machine is greatly augmented by the new table support, which is a part of the tool not an extra attachment. Increased ratio of back gearing provides ample power for any cut and meets the strain of high speed steels. Power elevating device for table gives an automatic feed for vertical surfaces. Special conveniences for operating. Back gears on all sizes.

Ask for new circular.

THE R. A. KELLY CO., Xenia, Ohio

ROBBINS ENGINE LATHES



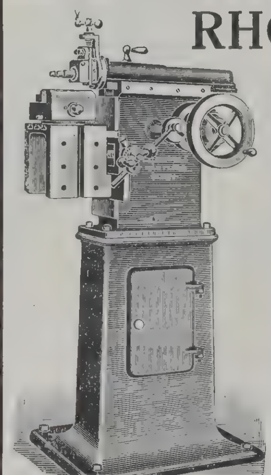
Our 13 and 15″ Engine Lathes are of massive and powerful design, strongly back geared and furnished with compound rest and regular attachments. The range of feeds and speeds is ample, cone carries extra wide belt and operating convenience is a feature. We also make a 16″ Pattern Makers' Lathe.

Send for circulars.

THE ROBBINS MACHINE CO.

149 Lagrange Street Worcester, Mass., U. S. A.

RHODES SHAPERS



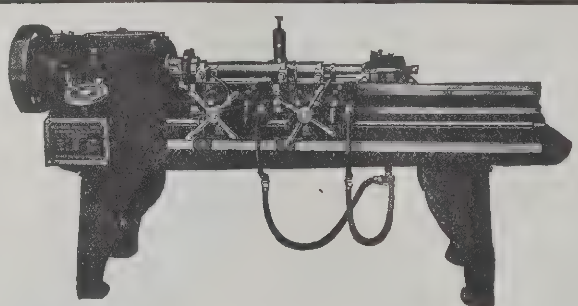
This is our 7″ Shaper which has all the essential features of the high priced machine, and is especially adapted for all kinds of light tool and die work, and any class of work that comes within its range.

Has Micrometer adjustments and graduated swivel vise and head.

Can you afford to be without this LITTLE MONEY MAKER? Send for circulars to

L. E. RHODES

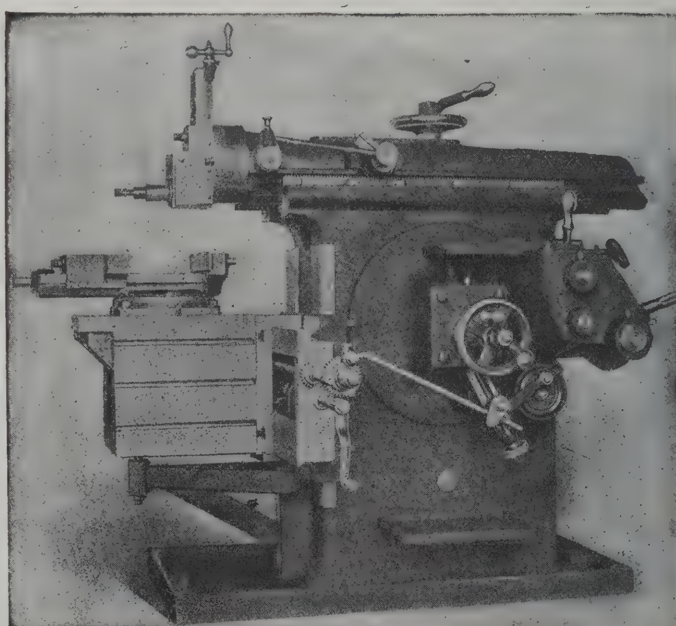
HARTFORD -- CONNECTICUT



The Lo-swing Lathe

Does more than double the output of any engine lathe on the same work. Great driving power, rigidity, extreme accuracy and perfect control of work are but a few of its details. *Catalog?*

FITCHBURG MACHINE WORKS, Fitchburg, Mass.



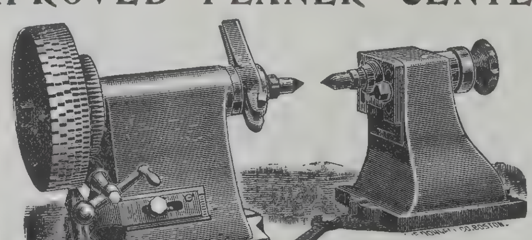
16-INCH SHAPER

The driving mechanism of Flather Shapers is more powerful and uniform than any other shaper in the market and we welcome an opportunity to prove it.

The Mark Flather Planer Co.

NASHUA, N. H.

IMPROVED PLANER CENTERS

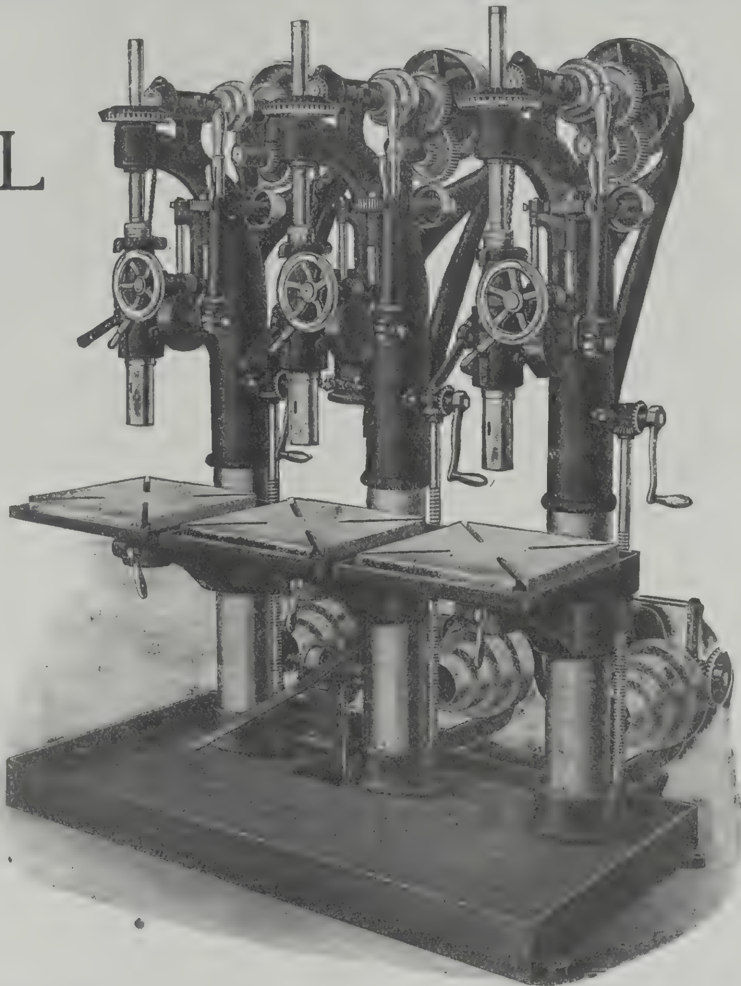


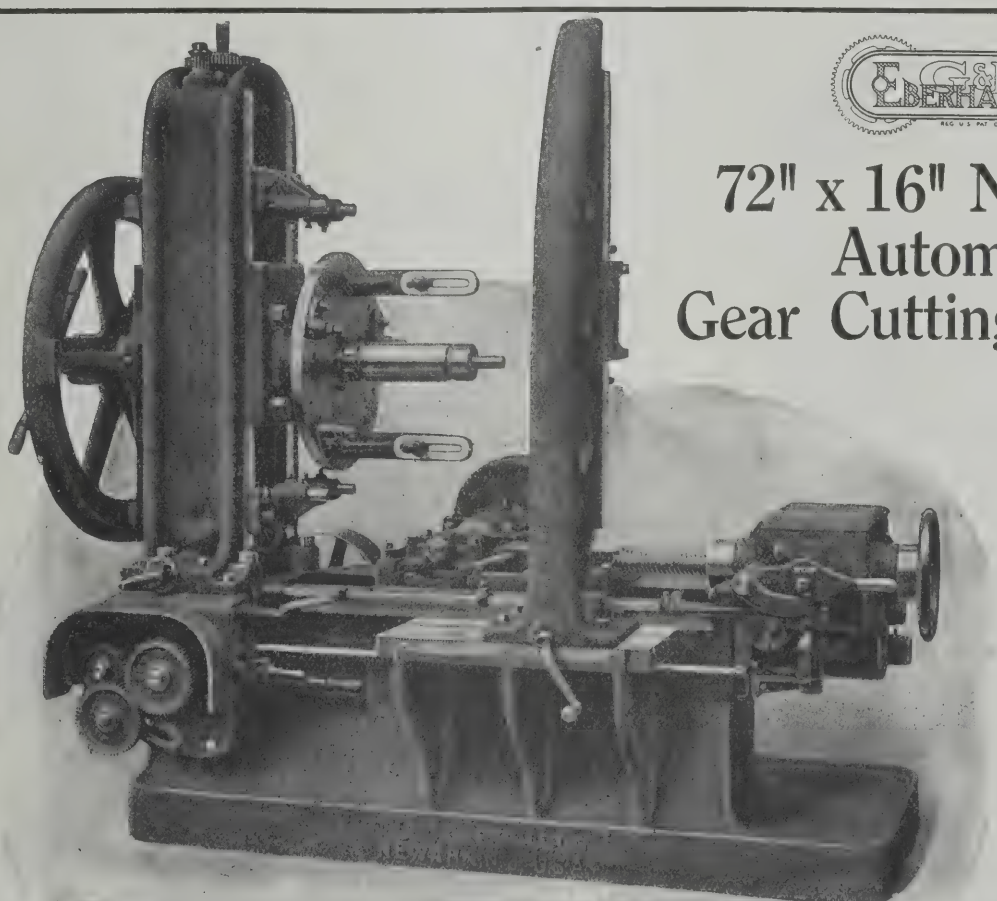
Three sizes, 13, 20 and 36 inch

Adapted to any work that has to be carried on centers to be planed or milled, and that requires to be accurately indexed or spaced. The index plates are of large diameter and are cut through, like a gear tooth, which allows the use of a much stronger pin than with a drilled index Both work and index are revolved with a worm and gear, readily disengaged Tail stock centre is adjustable vertically, for planing bevels and tapers. The device is easily attached without destroying the alignment.

FAY & SCOTT, Manufacturers, Dexter, Maine

Engine, Chucking, Turret, Extension Gap, Double Head Facing and Patternmakers' Lathes. Lathe Turrets for any make of lathes.





ROCKFORD MULTIPLE DRILLS

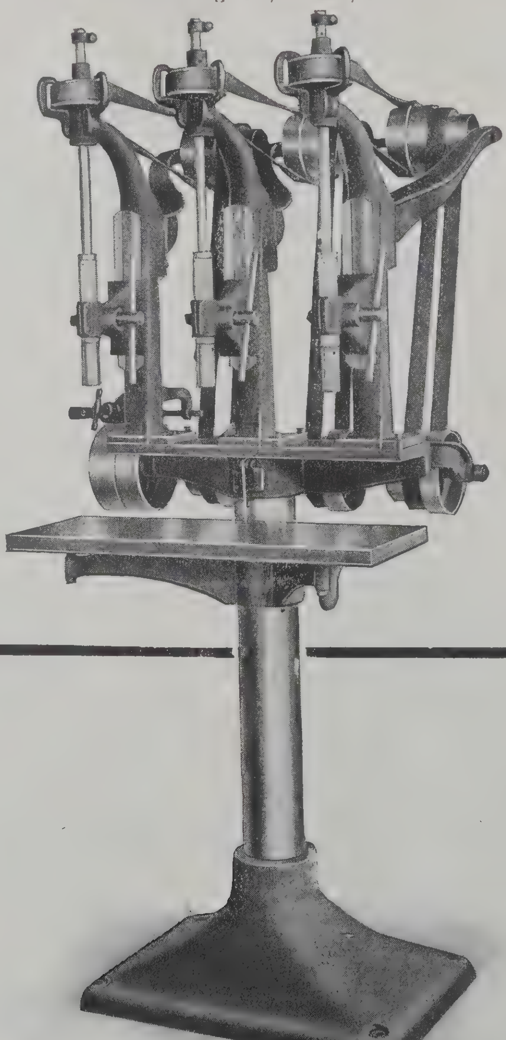
A new line of machines that will make their mark in the manufacturing field. The 3 Spindle, Floor Type Drill is representative. It is heavily constructed, has self contained countershaft, 3 spindle speeds for each speed of the countershaft, permitting each spindle to run at the proper speed for drills, counterbores, etc., of varying diameters. The table on this machine is 12″ x 30″ in size, counterbalanced and is mounted on three point support which assures perfect alignment with the spindle, and contributes to rapid and accurate work.

Built with one, two, three or four Spindles.
Bench and Floor types. Ask us for the details.

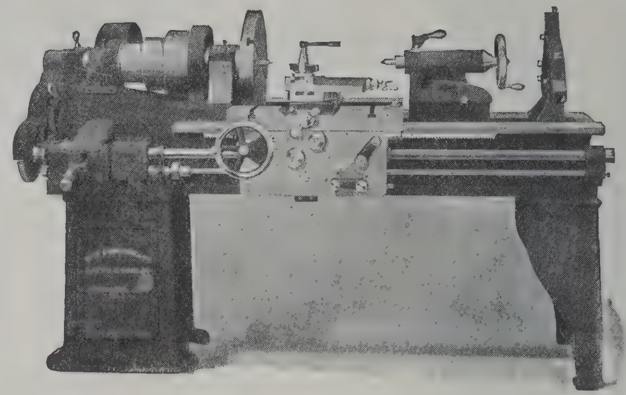
The Rockford Lathe and Drill Company

ROCKFORD, ILL., U. S. A.

AMERICAN DEALERS: O. L. Packard Mchy. Co., Chicago, Ill., Milwaukee, Wis. Prentiss Tool & Supply Co., New York, N. Y., Syracuse, N. Y., Buffalo, N. Y., Boston, Mass. Baird Mchy. Co., Pittsburgh, Pa. E A. Kinsey Co., Indianapolis, Ind., Cincinnati, O. W. M. Pattison Supply Co., Cleveland, O. W. R. Colcord, St. Louis, Mo. Harron, Rickard & McCone Co., San Francisco, Cal., Los Angeles, Cal. Northern Mchy. Co., Minneapolis, Minn. Zimmerman-Wells-Brown Co., Portland, Ore. The English Tool & Supply Co., Kansas City, Mo. The National Supply Co., Toledo, O. Chas. A. Strelinger Co., Detroit, Mich. Vandyck-Churchill Co., Philadelphia, Pa. Aumen Mchy. Co., Baltimore, Md. Hendrie Bolthoff Mfg. Co., Denver, Col.



Cincinnati Lathes



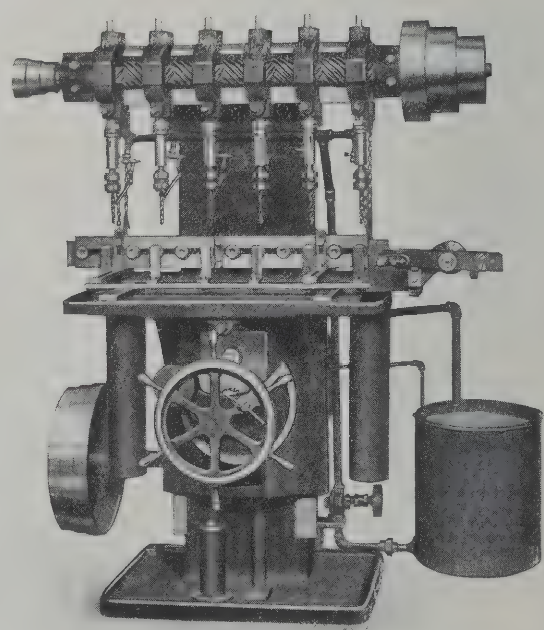
represent that good construction in every detail below which it is neither safe nor wise to go. Our latest literature fully describes about their **All Geared Feed Devices**, five step or extra wide three step cone. **Apron of box type construction** and other important features it pays to investigate.

The Cincinnati Lathe & Tool Co.,

STATION B

Cincinnati, Ohio, U. S. A.

Moline Multiple Spindle Pin Drill with Sliding Jig for Drilling Brake Pins and work of a similar class.



This machine is especially adapted for its work and has every convenience for handling. Shifting jig permits changing work while drilling is in progress, making the drilling action practically continuous. Jig also adjustable for different diameters and lengths of pins. Full description on request.

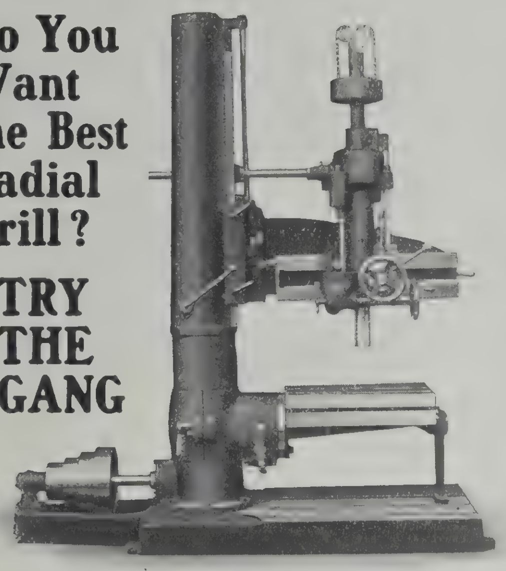
Multiple Spindle and Gang Drills for all purposes.

MOLINE TOOL COMPANY, Moline, Ill., U.S.A.

AGENTS: Marshall & Huschart Machinery Co., Chicago, Milwaukee, St. Louis and Indianapolis.

Do You Want the Best Radial Drill?

TRY THE GANG



It has the most direct drive of any machine of its class—is more easily controlled—has capacity for a wide range of work—strength and rigidity for heavy cuts. All our machines are compact in shape and without complicated mechanism.

Write for special details.

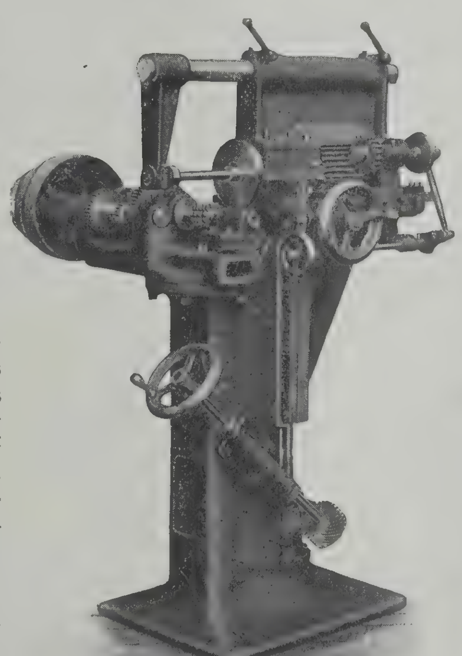
THE WM. E. GANG CO., Cincinnati, Ohio

Domestic Agents—Hill, Clarke & Co., Boston, Chicago, Philadelphia and New York. C. H. Wood Co., Syracuse, N. Y. Baird Mchy. Co., Pittsburg, Pa. Miller Supply Co., Huntington, W. Va. W. M. Pattison Supply Co., Cleveland, O. Osborne & Sexton Mchy. Co., Columbus, O W. R. Colcord Mchy. Co., St. Louis, Mo. Perine Mchy. Co., Seattle, Wash. Hewitt Mchy. Co., San Francisco, Cal.

Foreign Agents—Williams & Wilson, Montreal, Canada. H. W. Petrie, Toronto, Canada. Sanford & Co., Monterey, Mexico. Limbourg Freres, Brussels, Belgium. Adler & Eisenschitz, Milan, Italy. Buck & Hickman, London, England. V. Lowener, Copenhagen, Denmark. C. A. Swensson & Co., Stockholm, Sweden. Axel Christiernsson, Abo, Finland.

Simple, Strong and Direct

The Reynolds Gear Hobbing Machine



is an ideal producer of accurate Spur Gears. There is no complicated mechanism requiring a highly trained operator. All unnecessary joints and adjustments are eliminated by the use of hobs of fixed thread angle. The power is applied directly to the hob.

Strength and stiffness are special features, ample support for both work and tools is furnished. The machine is designed especially for the use of high speed tools, and is guaranteed to drive them to their limit.

Detailed description of this machine will be sent on request, also circular of the Reynolds Power Screw Driving Machine.

Reynolds Machinery Company
MOLINE, ILLINOIS

Before you can keep your Loose Pulleys properly oiled, you'll have to eliminate centrifugal force—

AND THAT'S

A BIG ORDER

Why be wedded to the oil can, when ARGUTO OILLESS BEARINGS will rid you of having to oil your Loose Pulleys and reduce your friction losses?

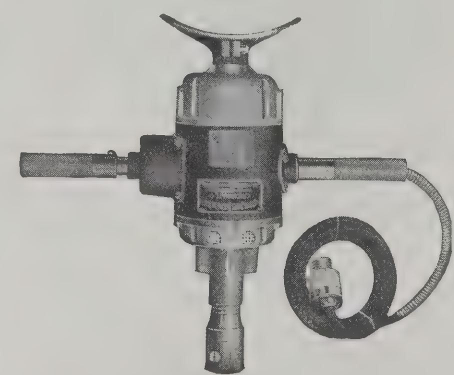
It is not much to look at and nothing to look after.

Arguto Oilless Bearing Co.
Wayne Junction
Phila., Pa.

COPYRIGHTED 1909 BY ARGUTO OILLESS BEARING CO.

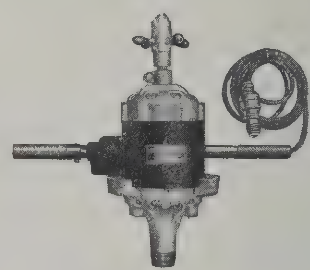
U. S. ELECTRICAL DRILLS

are considered by manufacturers who have had experience with other makes to be the best on the market. One large firm in Indianapolis who has been using U. S. drills, recently sent seven of another make to us and said **"make us an allowance, replacing same with U. S. drills."** This is only one case where we have replaced other make drills. **WHY?** For the reason that U. S. drills stand up to the work, and are not in use one half of the time and the other half in the repair shop. We consider every trial order a sale. Let us send you one or write for our late catalog. We can refer you to users in any city or country in the world.

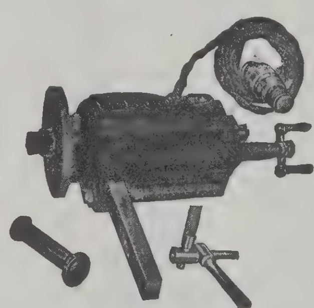


3/8" drill, switch in handle, for drilling in steel. Air-cooled motor. 1/2" drill made in same style. Also corner drills.

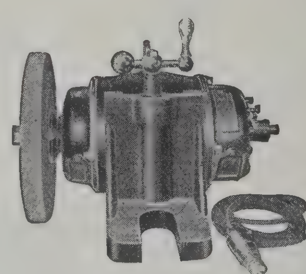
We Manufacture the Largest Line of Portable Electric Tools in the WORLD



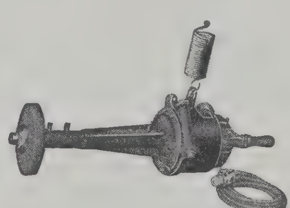
Made in 4 Sizes—3/4 - 1—1 1/4 and 2". Drills in Steel.



CENTER GRINDERS.
For grinding Centers, Cutters, Dies, Rolls and Internal and Surface Grinding. Set in Tool Post of Lathe Planer or Milling Machine.

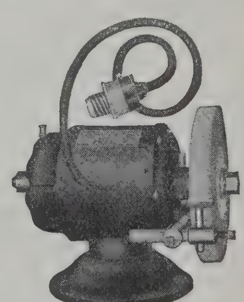


For heavy grinding. This style Grinder is made with an angle plate; has a vertical adjustment; is adapted for grinding large rolls, or grinding on planer or boring mill. Made in 4 sizes —1/2 H.P. 1, 2, 3 H.P. runs off lamp socket.



TYPE O. SURFACE GRINDER.
Made in three sizes.
This grinder was particularly devised for rough surface grinding and the cleaning of castings of any kind. It also does away with hand filing and chipping. Can be suspended anywhere. Carries cloth wheel for grinding off filler or polishing metal surface.

MADE FOR DIRECT OR ALTERNATING CURRENT

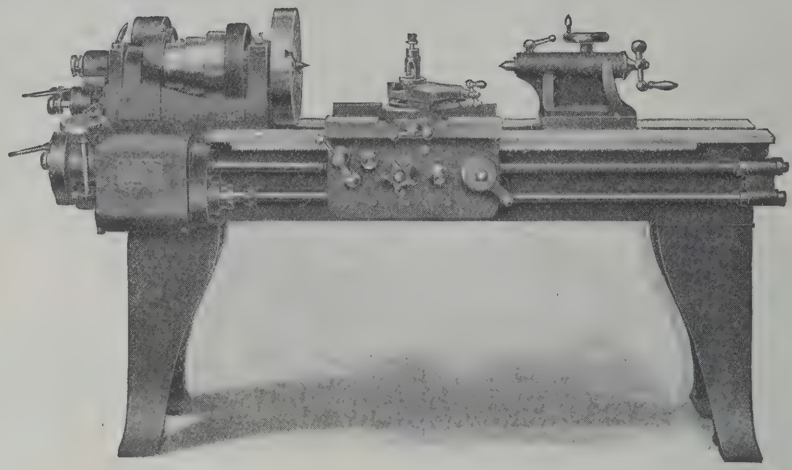


Bench Grinders. Just attach to lamp socket. 4 sizes—1/4—1/2—1—2 H.P.

The United States Electrical Tool Company

Cincinnati, Ohio, U. S. A.

FOREIGN AGENTS: Canadian Fairbanks Co., Montreal, St. Johns, Toronto, Winnipeg, Calgary and Vancouver. Selig, Sonnenthal & Co., London, England. Wilh. Sonesson & Co., Malmo, Stockholm and Gothenburg. Aktieselskabet, Denmark, Finland. J. S. Cock, Christiania, Norway. Glaenzer, Perreaud & Thomine, Paris, France. Hans Schulze, Brunn, Austria.



Two classes of high grade tools

Second Belt Drive Planers

22" to 30" Sizes
17" Geared Planer

Second Belt Drive Planers not only consume less power than full geared machines, but produce more work in a given time, run more smoothly, wear longer, are more convenient in operation and can be run at speeds that would ruin a full geared planer.

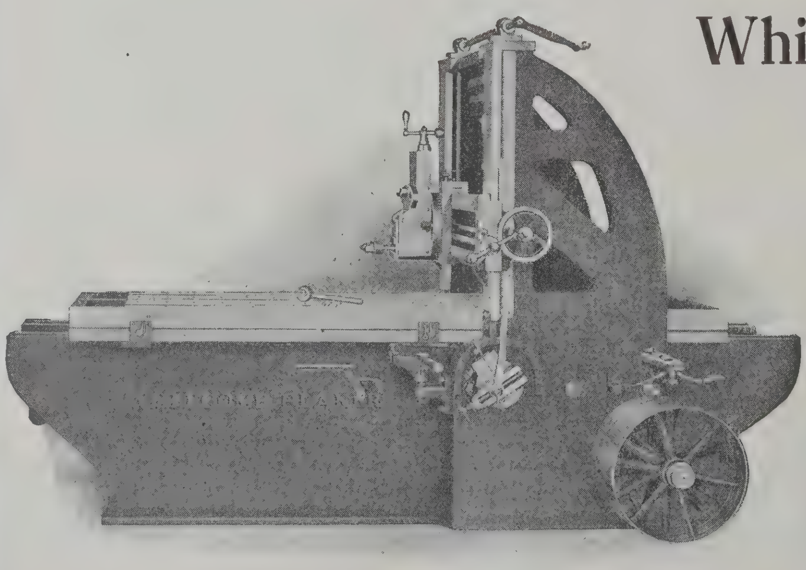
AND

that will make a difference in production costs and in the daily output of accurate and well finished work.

Catalogues cover the full line of machines and will be mailed on request.

New Type High Speed Engine Lathes

Our High Speed Engine Lathes are of new design, rigidly constructed and have every facility for rapid operation. All speeds and feeds are quickly and easily obtained. Double back gears and a three step cone carrying an extra wide belt materially increase the power. Feed works are made heavy and strong to meet any requirement that may be put upon them by the powerful head.



Whitcomb-Blaisdell Machine Tool Co.

Worcester, Mass., U.S.A.

AGENTS: Hill, Clarke & Co., Boston, Chicago and Cleveland, O Vandyck Churchill & Co., New York and Philadelphia. Thomas & Lowe Machinery Co., Providence, R. I. C. H. Wood Co., Syracuse, N. Y. E. L. Essley Machinery Co., Chicago, Ill. Marshall & Husohart Machinery Co., St. Louis, Mo. J. L. Osgood, Buffalo, N. Y. Perine Machinery Co., Seattle, Wash. Compressed Air Machinery Co., San Francisco, Cal. Somers, Fitler & Todd Co., Pittsburg, Pa. Chas. A. Strelinger Co., Detroit, Mich. Zimmerman-Wells-Brown Co., Portland, Ore. Smith-Booth-Usher Co., Los Angeles, Cal. C. W. Burton, Griffiths & Co., London, England. Fenwick Freres & Co, Paris, France. Ludw. Loewe & Co., Berlin, Germany. De Fries & Co., Dusseldorf, Germany. Wilh. Sonesson & Co, Malmo, Stockholm, Gothenburg, for Sweden. Aktieselskabet, Wilh. Sonesson & Co., Copenhagen City and Freeport, for Denmark, Norway and Finland Van Rietschoten & Houwens, Rotterdam, Holland. Williams & Wilson, Montreal Canada. A. R. Williams Machinery Co., Toronto, Canada.

WE HAVE BEEN MAKING

Cleveland Open Side Planers

FOR THE PAST SEVEN YEARS.

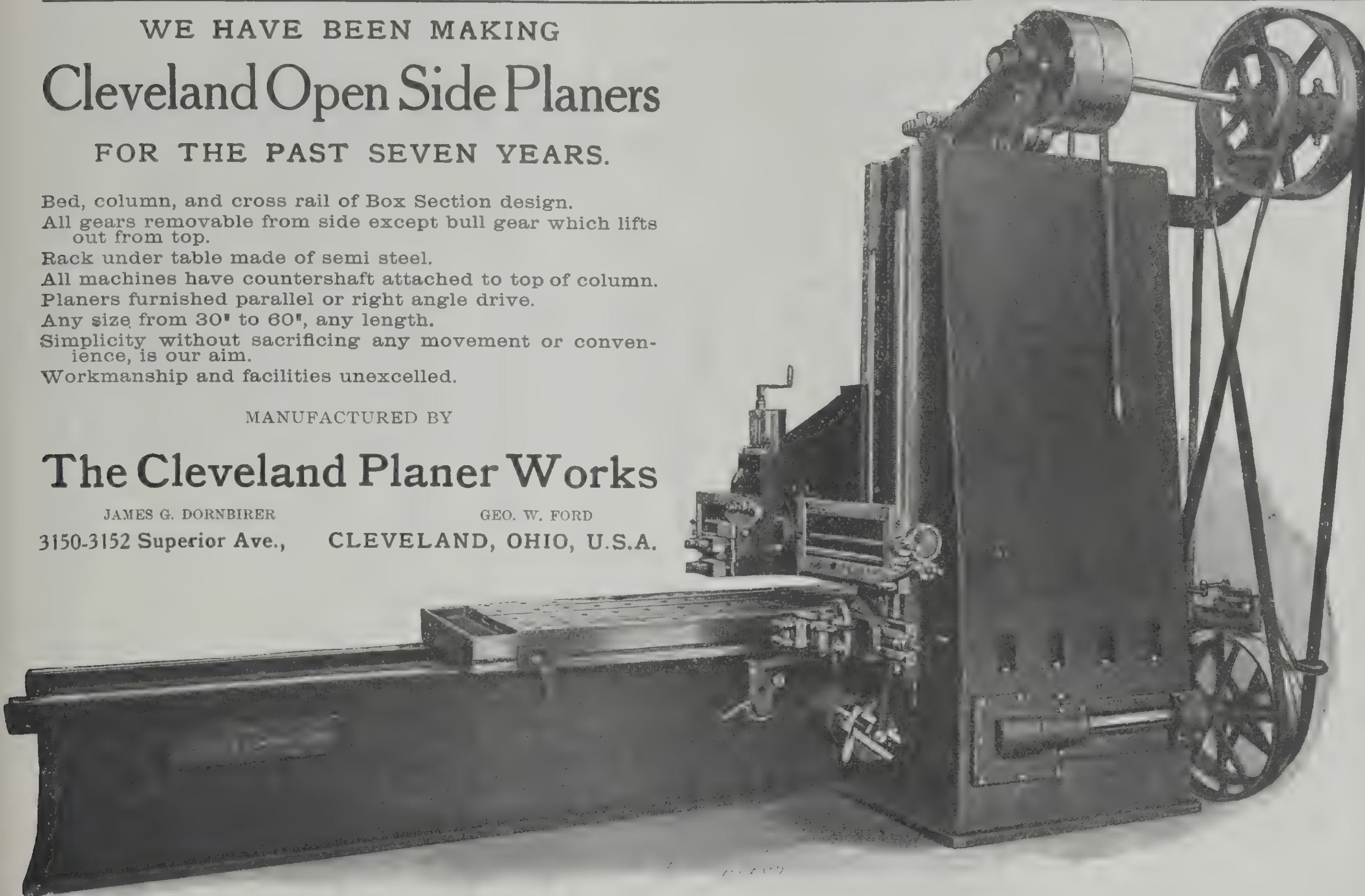
Bed, column, and cross rail of Box Section design.
All gears removable from side except bull gear which lifts out from top.
Rack under table made of semi steel.
All machines have countershaft attached to top of column.
Planers furnished parallel or right angle drive.
Any size from 30" to 60", any length.
Simplicity without sacrificing any movement or convenience, is our aim.
Workmanship and facilities unexcelled.

MANUFACTURED BY

The Cleveland Planer Works

JAMES G. DORNBIRER GEO. W. FORD

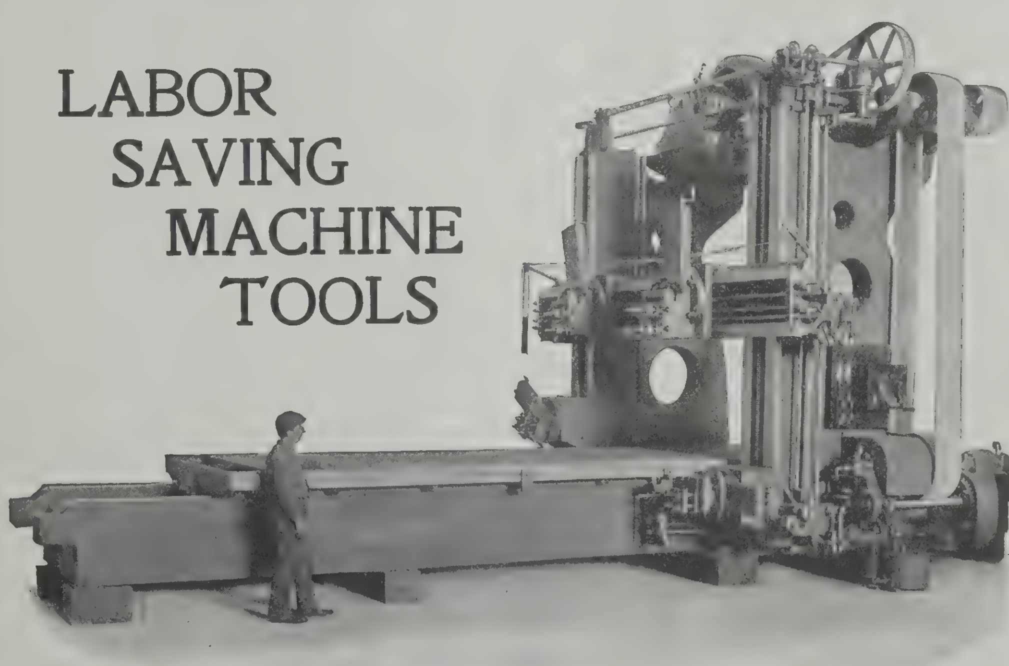
3150-3152 Superior Ave., CLEVELAND, OHIO, U.S.A.



60-in. x 60-in.—14-ft. Cleveland Planer.

William Sellers & Co., Incorp. Philadelphia, Pa.

LABOR SAVING MACHINE TOOLS



PNEUMATIC CLUTCH PLANING MACHINES

Noted for remarkable uniformity of reverse without shock.

Driven by non-shifting belt running always in same direction.

Variable cutting speed.

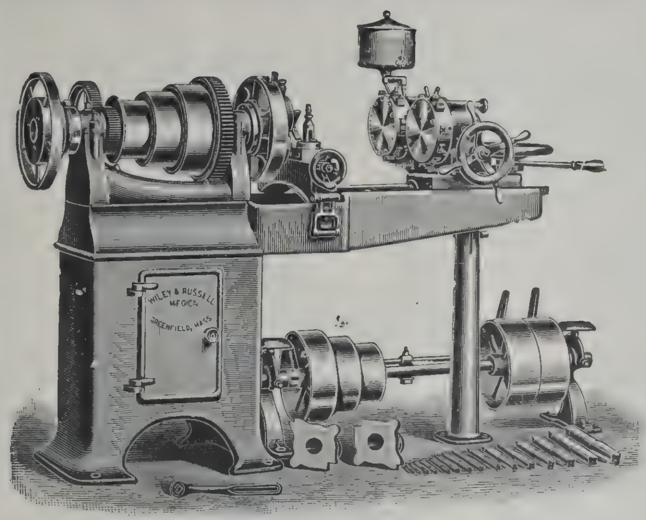
Constant return.

Crosshead extended back between uprights and secured front and rear. Patent feed motion. Uprights of heavy box form.

Ways lubricated by power pump.

Catalogue No. 700 mailed on request.

CRANES - INJECTORS - SHAFTING - TURNTABLES - ETC.



Green River Opening-Die Bolt-Cutter, Nut-Tapper, Pipe-Threader and Cutting-Off Machine :: ::

"You can change from one size die to another in less than one minute's time."

TESTIMONIAL

East Hampton, Conn., Sept. 22d, 1909.
Messrs. Wiley & Russell Mfg. Co,
Greenfield, Mass.

Gentlemen:—In reply to your inquiry of September 14th, would say that after a careful consideration of the merits of the various pipe cutting and threading machines on the market, we purchased one of your No. 50 Bolt and Pipe Cutting Machines for use in the plumbing and steam fitting department of our mill, and after about two months use of this machine, we are pleased to say that it more than meets our expectations.

One of the essential requirements in work of this class is, that the *changes for different sizes of pipe be easily and quickly made*, and this feature, your machine possesses above all others that we have examined.

The machine is strongly driven, and never hesitates on pipe of the full capacity of the machine (2").

With the scroll chuck on rear end of spindle, we believe that you have the *best Pipe Cutting and Threading Machine*, particularly for the plant doing its own steam fitting, that is now on the market.

Wishing you success, and assuring you of our further patronage, we beg to remain,

Yours very respectfully,
(Signed) Summit Thread Co.

The only machine on the market for repair shops, R. R. and machine shops where a few bolts or pipes of a variety of sizes are to be threaded. *Write for prices, catalog 34-E and book of testimonials.*

SOLE MAKERS

Wiley & Russell Mfg. Co.

GREENFIELD, MASS., U. S. A.

British Agents: Selig, Sonnenthal & Co., 85 Queen Victoria Street, London, E. C.

Little Giant

DIE HOLDERS

¶ This is one of a line of Die Holders for Screw Machines which we are now prepared to furnish.

¶ The model shown is made to take the celebrated LITTLE GIANT dies, but we have other models taking spring screw threading dies, and others in solid form without the interior clutch shown in this model.

¶ The shank of this Holder is hollow permitting any length of thread to be cut. The jaws of the clutch engage and disengage without difficulty, and without the hammering that ruins the jaws of the clutch.

¶ NO STRIPPED THREADS IN BACKING OFF.

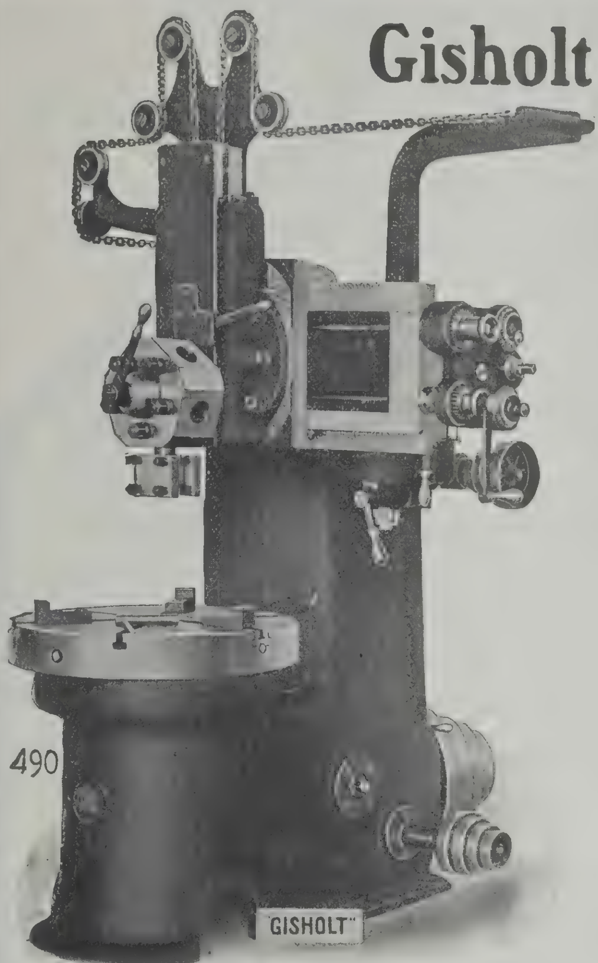
Write for "DIE HOLDERS," It's CATALOG No. 24.

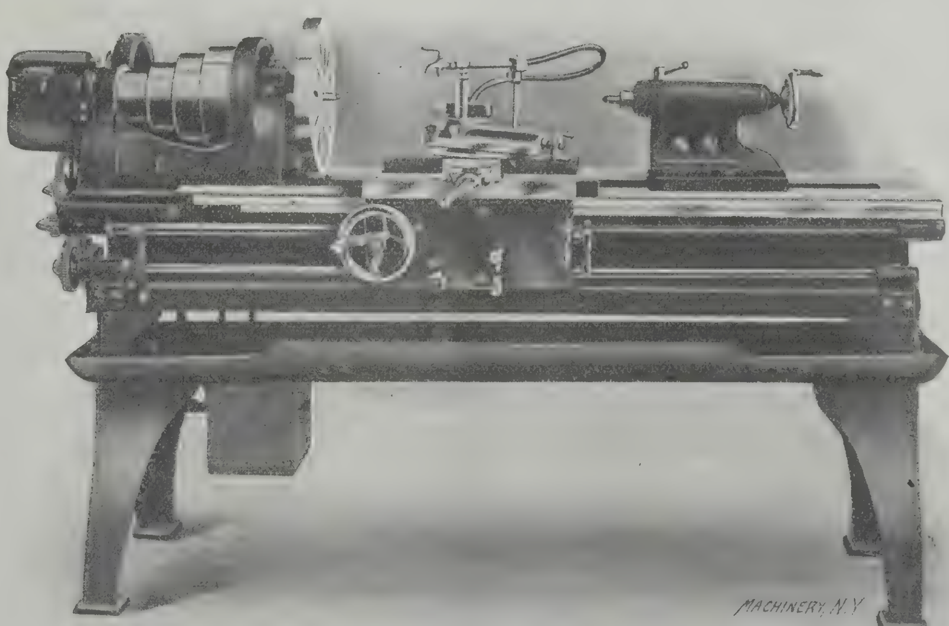
Wells Bros. Company

GREENFIELD, MASS., U. S. A.

NEW YORK CHICAGO LONDON

Little Giant





The Eclipse Sectional Rainbow Gasket

The Eclipse Sectional Rainbow Gasket is the only tubular Gasket in the world that will hold 3,000 pounds pressure and that will do the work. Why? Because it is the only Gasket that is made of the

Celebrated

Rainbow Packing Compound

3/8-inch, 1/2-inch, 5/8-inch
For Hand Holes
In Boxes 3 to 5 lbs.

3/4-inch, 7/8-inch, 1-inch
For Extra Large Joints
In Boxes 4 to 6 lbs.

Fac-Simile of a 6-inch Section of Eclipse Gasket Showing Name and Trade-Mark Imbeded

We have the most modern and Extensive Rubber Factory in the World and manufacture the highest grade of all kinds of mechanical rubber goods, including

- Pump Valves
- Gauge Glass Rings
- Gaskets and Rings
- Rubber Buckets and Pails
- Discs
- Rubber Belting
- Packings
- Rubber Springs
- Rubber Gas Bags
- Rubber Hat Bags
- Fire Hose
- Landing Pads
- Hose Nipple Caps
- Mats, Matting
- Rubber Mallets
- Tiling
- Faucet Balls
- Garden Hose
- Tubing
- Diaphragms
- Air Brake Hose
- Steam Hose
- Suction Hose
- Pneumatic Tool Hose

SOLE MANUFACTURERS OF THE CELEBRATED RAINBOW PACKING

MANUFACTURED EXCLUSIVELY BY

The Peerless Rubber Manufacturing Company

16 Warren Street and 88 Chambers Street, New York

Detroit, Mich., 24 Woodward Ave.
Chicago, Ill., 202-210 South Water St.
Indianapolis, Ind., 38-42 S. Capital Ave.
Louisville, Ky., N. E. Cor. Second and Washington Sts.
New Orleans, La., Cor. Common and Tchoupitoulas Sts.
San Francisco, Cal., 416-422 Mission St.
Seattle, Wash., 212-216 Jackson St.
Omaha, Neb., 1218 Farnam St.
Spokane, Wash., 1016-1018 Railroad Ave.

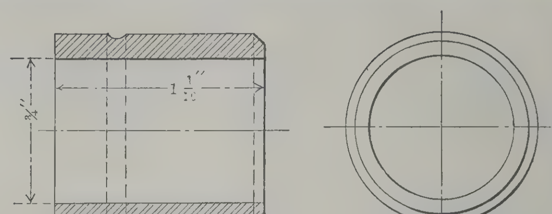
Richmond, Va., 1323 E. Main St.
Philadelphia, Pa., 245-247 Master St.
Dallas, Texas, 177 Elm St.
Memphis, Tenn., 228 Front St.
St. Louis, Mo., 1213 Locust St.
Denver, Col., 1556 Wazee St.
Kansas City, Mo., 1221-1223 Union Ave.
Waco, Texas, 709-711 Austin Ave.
Tacoma, Wash., 1316-1318 A St.

Pittsburg, Pa., 425-427 First Ave.
Atlanta, Ga., 7-9 S. Broad St.
Columbus, Ohio, Cor. Long and Third Sts.
Cleveland, Ohio, 61 Frankfort St.
Buffalo, N. Y., 379-383 Washington St.
Boston, Mass., 110 Federal St.
Syracuse, N. Y., 212-214 S. Clinton St.
Rochester, N. Y., 55 E. Main St.
Portland, Ore., 27-29 N. Front St.

By Way of Example

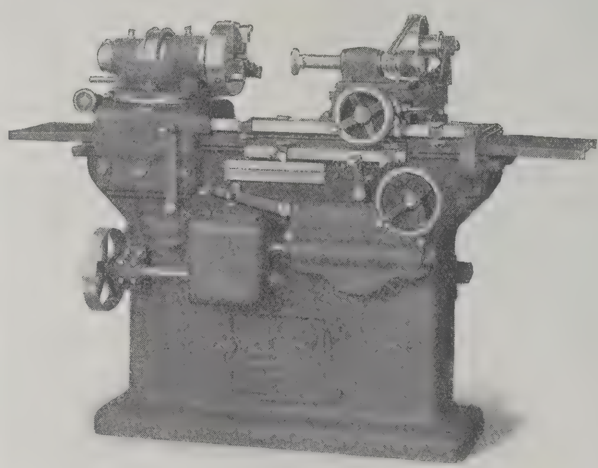
We show herewith what can be done in rapid grinding on the

Heald Internal Grinder



Bushing Machinery steel, case hardened; .008 stock removed; grinding time, 2 minutes

JUST a sample of every day work turned out on this machine, which meets the demands of modern manufacturing fairly and exactly. The Heald Internal Grinder is so designed that the grinding wheel is rigidly supported, eliminating vibration, giving a smooth motion and perfect contact and permitting heavy work to be handled with least wear to the wheel. Five different speeds of rotation for the work, cover various sizes of holes and materials to be ground, and there are three different speeds of table travel for each of the work speeds.



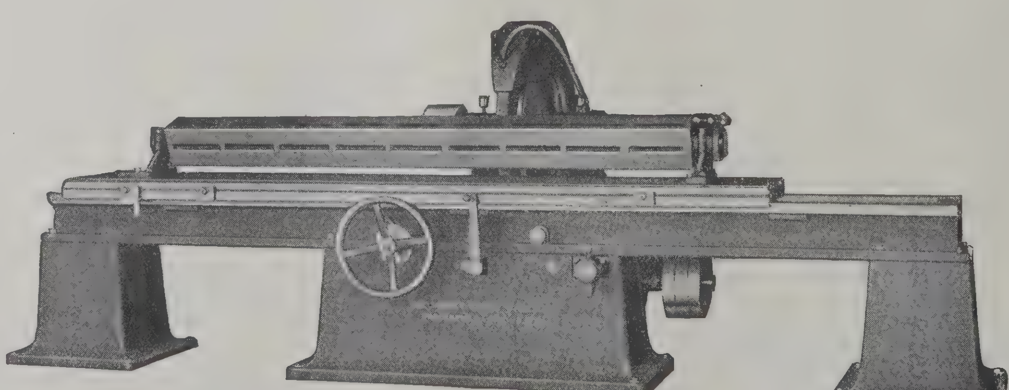
Every convenience for easy operation. Especially adapted for automobile, gas engine, and similar lines of work. *Catalogue on request.*

The Heald Machine Company
20 New Bond Street Worcester, Mass.

All Speeds are Safe with Safety Wheels

With the safety collar in position your wheels are as safe running at highest speeds as at low speed without it. Safety Wheels are graded to suit every class of work. Are made in all the necessary sizes and shapes to fit standard grinding machines, combine uniform hardness with perfect porosity, are durable, free cutting, not affected by oils or acids and will stand the test of time. Made of Emery, Corundum and Carbondite. Unequalled for strength and long service.

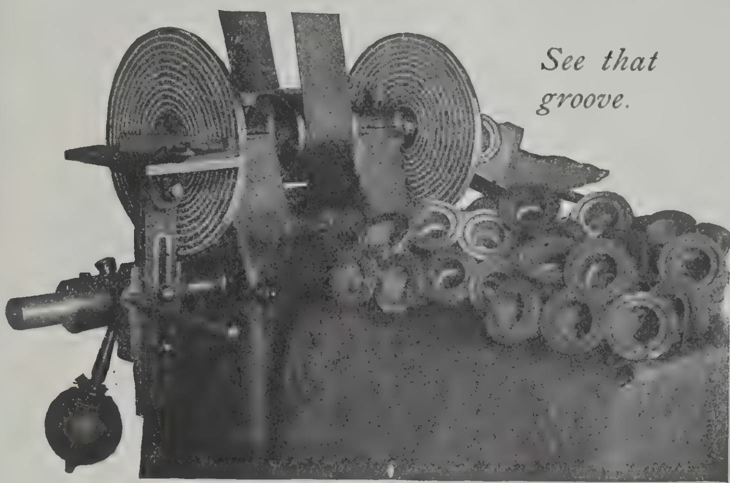
Glad to "show you"



THE SAFETY EMERY WHEEL COMPANY, Springfield, Ohio

FOREIGN REPRESENTATIVES—Pfell & Co., London. V. Lowener & Co., Copenhagen. Adler & Eisenschitz, Milan. De Fries & Co., Act. Ges., Dusseldorf, Berlin, Wien and Paris. J. R. Baxter & Co., Montreal, Canada.

This Designer was up on Besly Grinding Practice



Facing Cast Iron Pump Flanges

Castings are thin, dense and hard.

Stock removed—enough to clean up, about 1-16″.

Machine, No. 14-23 K Besly Grinder with suitable angle plate workholder bolted to GEARED lever feed table.

Time, 120 pieces per hour

Note: Pattern was changed to leave a groove in the surface as shown. This groove reduces area of ground surface, provides a discharge for the grindings, reduces travel of grindings and makes this job a big success on the disc grinder.

ARE YOU UP ON DISC GRINDING?

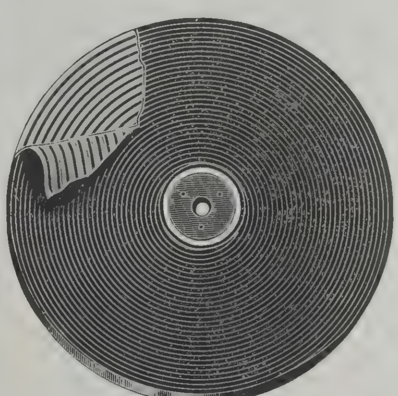
Does your shop enjoy the advantages of modern disc grinding equipment? If not, your competitor who is equipped, has an advantage over you by reason of his low manufacturing costs.

Grinding is done by emery (or other abrasive) cloth sheets, called circles, glued to the faces of steel disc wheels. When the circles become worn, they are torn off the steel wheels and new circles glued and pressed on.

The BESLY GRINDER is used chiefly for making, perfecting and finishing flat surfaces of metal. It can be *operated by unskilled labor*, and work for which it is adapted is done in a fraction of the time required by the lathe, planer, shaper, milling machine, file or any other type of surface grinder.

IMPROVES PRODUCT — INCREASES OUTPUT — REDUCES COST

BESLY GRINDER IS THE FASTEST SURFACE GRINDER IN EXISTENCE



Helmet Spiral Disc Wheel, Patented, with circle torn to show construction. The glue imbeds in the grooves, holding the circle firmly to the steel disc, and eliminating the danger of circle flying off when in use. The imbedded glue acts as a driver to the circle, same as the tail of a lathe dog. As some Besly Spiral Disc Grinders are capable of transmitting twenty horse power, this driver feature will be readily appreciated.

BECAUSE:

1st. It practically **ELIMINATES** usual **CHUCKING TIME,** because work can be allowed to "float" when forced against grinding wheel; therefore does not require rigid chucking.

2nd. The Helmet Spiral Disc Wheel **REMOVES METAL FASTER** than any other type of grinding wheel known.

3rd. The Helmet Spiral Disc Wheel **CUTS ALL OVER THE WORK AT ONCE.**

4th. The Helmet Spiral Disc Wheel **CANNOT BE BROKEN,** therefore gives operator a sense of security, conducive to greater production.

5th. ELASTIC hand FEED of the Besly Grinder gets FULL EFFICIENCY from grinding wheel, all the time. This, power feed cannot do.

Be Up On Disc Grinding, the Modern Way to Machine Flat Surfaces. Write today for illustrated booklet—"Besly's Modern Disc Grinding Practice" containing valuable information for Works Managers, Purchasing Agents, Designers, Draughtsmen, Shop Superintendents, Shop Foremen and Workmen. Mailed free on application.

Among our 80 varieties of BESLY GRINDERS is one just suited to your work. We would like to prove our claims on some of your samples. No charge for the demonstration. Send us some samples and we'll grind them for you and report time and material used.

CHARLES H. BESLY & COMPANY

CHICAGO (Originators of Disc Grinders) U. S. A.

Largest Manufacturers of Disc Grinders in the World

FOREIGN AGENTS—Canadian Fairbanks Co., Ltd., Calgary, Montreal, St. John, Toronto, Vancouver and Winnipeg. Buck & Hickman, London and Birmingham. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm, Copenhagen, Budapest and Shanghai. Alfred H. Schutte, Cologne, Paris, Brussels, Liege, Milan, Madrid, Bilbao and Barcelona. Thos. Drysdale & Co., Buenos Ayres. John Danks & Co., Melbourne and Sydney.

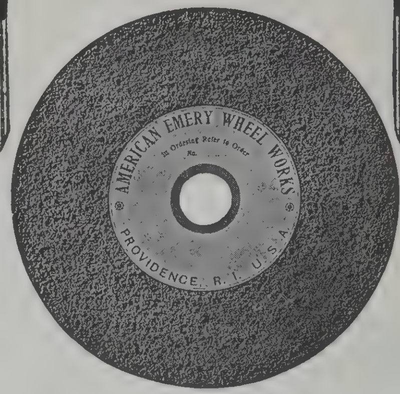
The cutting surface of a

Carborundum GRINDING WHEEL

is always sharp and clean—Carborundum is very hard and very brittle—The minute crystals of which a wheel is made break under pressure of grinding just enough to keep the surface continually fresh—
And yet the breaking is so slight that Carborundum Wheels last much longer than any other grinding wheels—
At the same time they cut much faster, and turn out fifty to a hundred percent more work in a day than any other wheels.
These two points, fast cutting and long lasting make Carborundum pre-eminent in the grinding field.

THE CARBORUNDUM CO.

NIAGARA FALLS, N. Y.



AMERICAN

CORUNDUM WHEELS——EMERY WHEELS

Special Abrasives for all Grinding Operations.

Made in every size, shape, grit and hardness by the Vitrified, Silicate and Elastic Processes.

ESSENTIAL POINTS OF SUPERIORITY

Rapidity and Coolness of cut, Safety, Maximum of Durability, Porosity, Uniformity, Accuracy of balance, Dimensions and Finish.

American Grinding Wheels are furnished with over 75% of the Grinders made in this country.

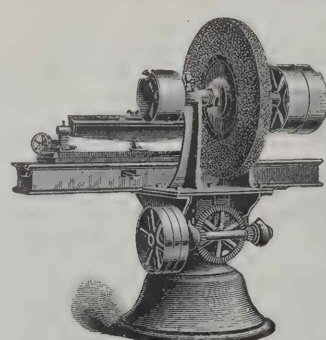
American Emery Wheel Works

Providence, Rhode Island, U. S. A.

Fenwick Freres & Co., Paris, Genoa, Milan, Brussels, Liege, Zurich; Hans Schulze, Vienna and Brunn, Austria; Heinrich Dreyer, Berlin, Germany; R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland; V. Lowener, Copenhagen, Christiania and Stockholm.

THE BEST

Automatic Knife Grinder



IN THE WORLD

FOR

$75.00

COMPLETE WITH WHEEL

The simplest, most durable and best automatic knife grinder on the market for the rapid and perfect grinding of planer, paper cutter, leather splitting, bark shaving mill, shear and other knives. Knives ground on this machine cannot be surpassed by any other process of grinding. After a wheel is worn out, the center can be recovered, saving cost of a wheel the size of center. By this method only the grinding material actually used is paid for. All parts are interchangeable and can be replaced at small cost. Large numbers have been sold in the United States and foreign countries, everywhere giving perfect satisfaction on account of quality and quantity of work done. Many large planing mills have had them in constant use for twenty years and upwards, proving their efficiency and durability. Why pay a large price for a knife grinder when this machine will do better and faster work at a much lower cost.

Send for catalog.

AMERICAN TWIST DRILL CO.

Established 1865. Dept. A, LACONIA, N. H.

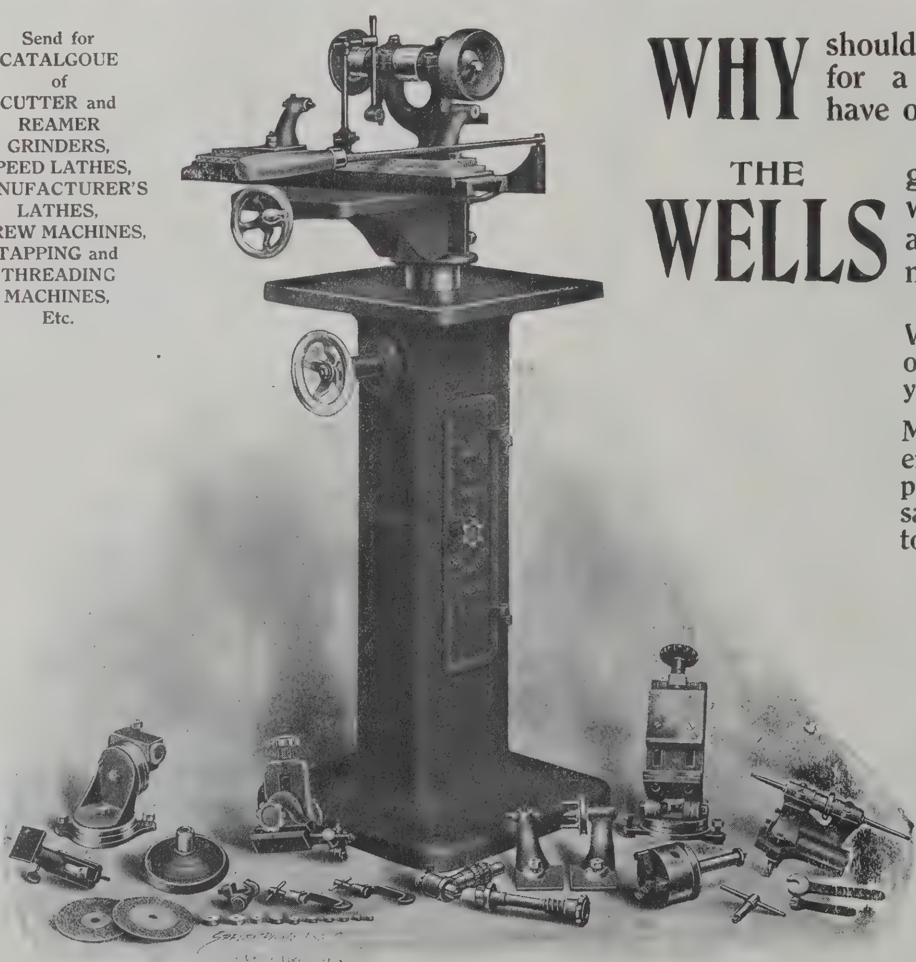
It's Seasonable and Reasonable to Use Cool Cutting Grinding Wheels

There is no advantage in speeding up a wheel and drawing the temper from the high speed tool you are grinding—you save time at the expense of the work. Vitrified Wheels are specified for high speed steel grinding because of their cool cutting qualities, which joined to efficiency, durability and special adaptability to modern grinding needs assures the ideal grinding wheel.

Write us for full particulars.
Our experience is yours to command.

Vitrified Wheel Company
Westfield, Mass., U. S. A.

Send for CATALGOUE of CUTTER and REAMER GRINDERS, SPEED LATHES, MANUFACTURER'S LATHES, SCREW MACHINES, TAPPING and THREADING MACHINES, Etc.



WHY should you pay so much more for a large grinder if you have only small tools to grind?

THE **WELLS** grinder does everything within its capacity as quick and accurate as a larger machine.

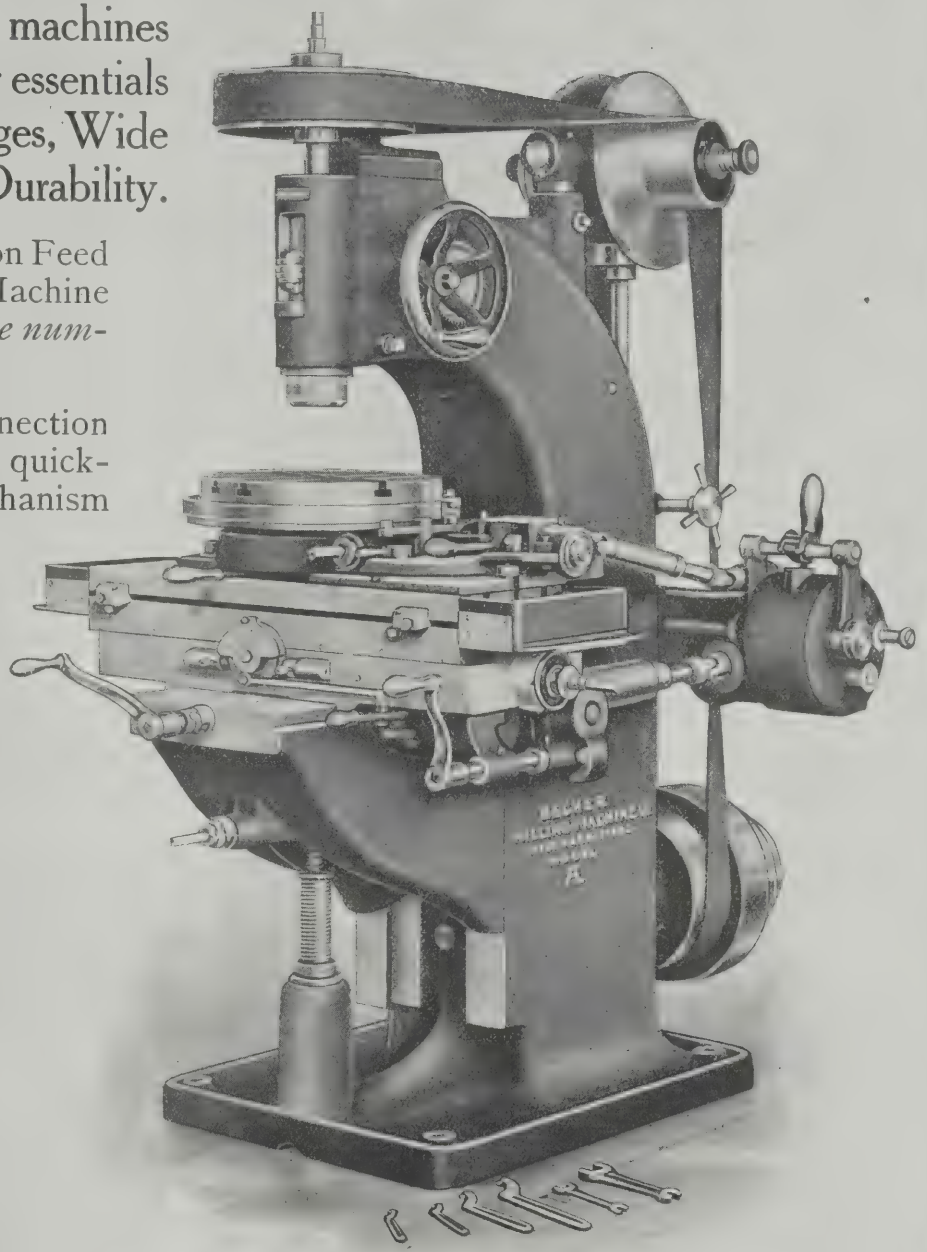
We sell it as a complete universal or with just the equipment for your particular work.

Many people keep Wells Grinders always set up for some particular kind of work and so save changing or waiting for tools to be ground.

IMMEDIATE DELIVERY
THROUGH FEBRUARY

F. E. WELLS & SON COMPANY
Wells
GREENFIELD, MASS. U.S.A.

The New Becker Friction Feed Vertical Milling Machine



The Ideal Drive for machines of this type has four essentials —Numerous Changes, Wide Range, Power and Durability.

The use of a Friction Feed on the Becker Machine provides an *infinite number of changes.*

And this in connection with a very simple quick-change gear mechanism gives a *wide range.*

The automatic action of the spindle belt on the pulleys, at all times assures *power in proportion to the demand of the cut.*

An original construction of the friction faces—peculiar to the Becker Machine — has solved the problem of *durability and efficiency in friction feed* and added another link to the chain of advantages.

Model "A," as shown, is adapted for a general line of milling and will prove a rapid and economical producer of high grade work.

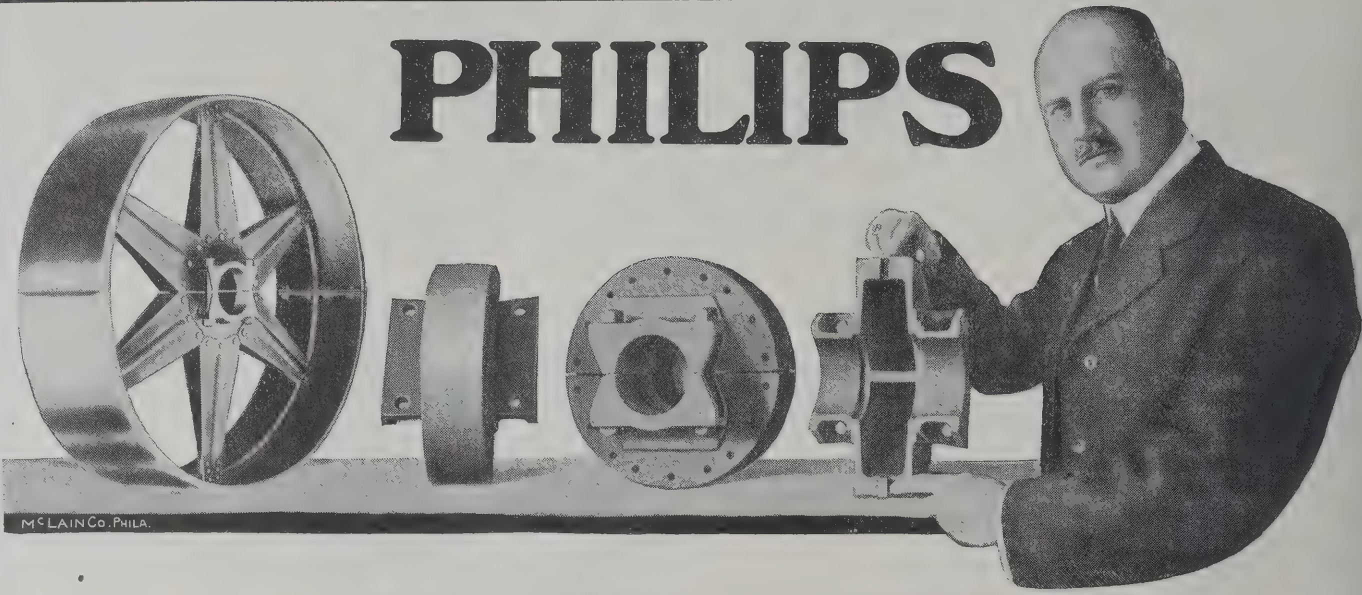
Special circular with full description.

The Becker Milling Machine Co.

HYDE PARK, MASS.

AGENTS—McDowell, Stocker & Co., Chicago. A. F. Kummel, Hartford, Conn. J. L. Osgood, Buffalo, N. Y. A. B. Bowman, St. Louis, Mo. Bevan & Edwards, Propty. Ltd., Melbourne, Australia. Selig, Sonnenthal & Co., London, England. Schuchardt & Schutte, Berlin, Germany; Vienna, Austria; Stockholm, Sweden; St. Petersburg, Russia; Copenhagen, Denmark; Budapest, Hungary; Shanghai, China; Tokio, Japan. A. H. Schutte, Cologne, Germany; Liege, Belgium; Milan, Italy; Barcelona, Spain; Brussels, Belgium; Paris, France; Bilbao, Spain. Ducas & Co., Austria-Hungary.

PHILIPS



ANOTHER REASON

Why the Philips Solves Your Pulley Problem!

Last month we told you about the Philips bushings. Next comes the Philips hub shown here. In order to maintain the same standard of accuracy possessed by the other features of the Philips pulley, the hub is substantially made of cast iron, bored and reamed true to insure a perfect fit on shaft.

We use cast iron instead of steel believing it impossible to draw steel into the same trueness and at the same time cast iron affords an absolutely firm hub stronger of necessity than a pressed steel hub where the fibres of the steel must be distorted in manufacturing.

The Philips hub is absolutely "fool proof" in application, as it can only be placed together in one position owing to the "tit" and groove which you can see where I'm pointing in this picture.

The Philips hub affords such perfect shaft grip that mere compression obtained by tightening the four (4) hub bolts (shown above) is sufficient to make the pulley absolutely rigid on the shaft.

IT IS IMPOSSIBLE TO CAUSE A PHILIPS PULLEY TO SLIP ON THE SHAFT WHEN IT IS PROPERLY APPLIED IN THIS MANNER.

This compression grip obtained by the Philips pulley obviates the necessity of all set screws or key ways.

The Philips hub used in conjunction with our bushing makes it possible to apply the Philips pulley to any sized shafting varying in 1-16 up to the bore of the hub.

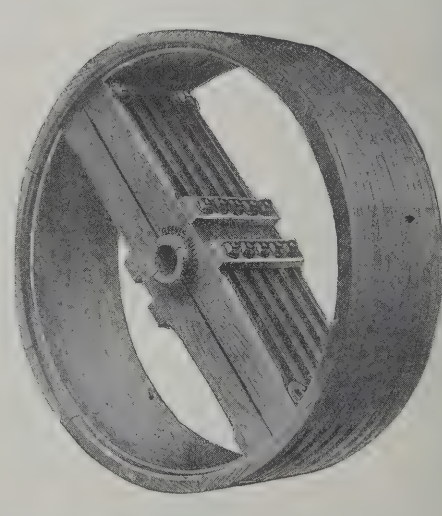
If we knew your name we would send you all the facts about the other details of the Philips pulley; the special bridge construction of the arms; the rim lug, which extends across the entire width of the pulley; (a usually weak point in other pulleys); the construction of the rim which makes possible the perfect, smooth, crown face to the Philips pulley, the surface of which is unbroken by either grooves or rivets.

These are only some of the brief facts. Send us your name now so we may send you the evidence, and let you judge for yourself whether the Philips isn't better than all other pulleys made.

PHILIPS PRESSED STEEL PULLEY WORKS, 341 Glenwood Avenue, Philadelphia, Pa.

"The Reeves"

WOOD-SPLIT PULLEY



Runs true and stays true. You never saw, you never heard of a pressed steel pulley which run true.

Again "The Reeves" has no rivets to shear, no arms to chatter, no hub pieces to work loose. It's as strong in wide faces as narrow ones. It can't spring and twist out of shape.

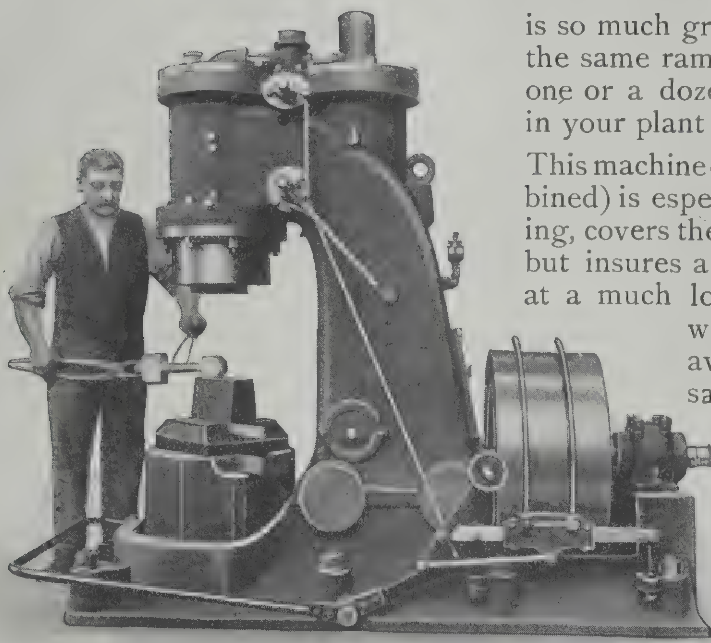
We appoint one exclusive agent in each jobbing center and we protect him to the limit. We pay no extra commissions or "hush money." We deal square with square people.

"The Reeves" Wood Split Pulley is the most profitable factory supply line in any store.

REEVES PULLEY COMPANY, Columbus, Indiana, U.S.A.

WRITE TODAY FOR AGENCY

The Efficiency of the Bêché Air Hammer



is so much greater than a Steam Hammer of the same ram weight that whether there is one or a dozen of the latter type machines in your plant there is need for a Beche.

This machine (Hammer and Compressor combined) is especially adapted for general forging, covers the same range as a steam hammer but insures a larger output and better work at a much lower cost. It can be installed wherever belt or motor drive is available, is simple in operation, safe, under positive control at all times, gets under way at once and maintains a uniform speed. More than 1000 already in use.

Full details in the Catalogue, let us send a copy.

NAZEL ENGINEERING AND MACHINE WORKS

Fifth and Luzerne Streets, PHILADELPHIA, PA., U. S. A.

Exclusive Manufacturers for United States and Canada.

Mental Indigestion is Mind Disturbance

Our Offer to machinists disturbs high prices for tools—only

THE STORY We have decided upon a plan to increase the output of the Sawyer Tool Co. and want every live machinist to read and digest the details of our special proposition. String-bearing offers are wearisome to the mechanic. We know he is influenced only, by legitimate, and really-important plans.

If you are a purchaser of tools, and desire the best at the least possible cost—consistent with high quality—we want your name and address to acquaint you with the benefits of our special reduction method.

You can continue to pay high prices for tools, but the purpose of this brief talk is to assure you it isn't necessary.

THE BURDEN We cheerfully assume the burden of convincing you that there is now opportunity for machinists in every shop and factory to profit by our plan. If we fail to convince you the loss is mostly ours.

Rash promises and the Sawyer Tool Co, are not friends. In all undertakings it has been the exponent of conservatism, strict adherence to principle, and a desire to satisfy those who place satisfaction first.

WE REPEAT Our proposition is new, novel and really worth while. It includes an offer that will enable you to get better tools at reduced cost, *with our guarantee of quality.* The most important details are for those that care to write for them.

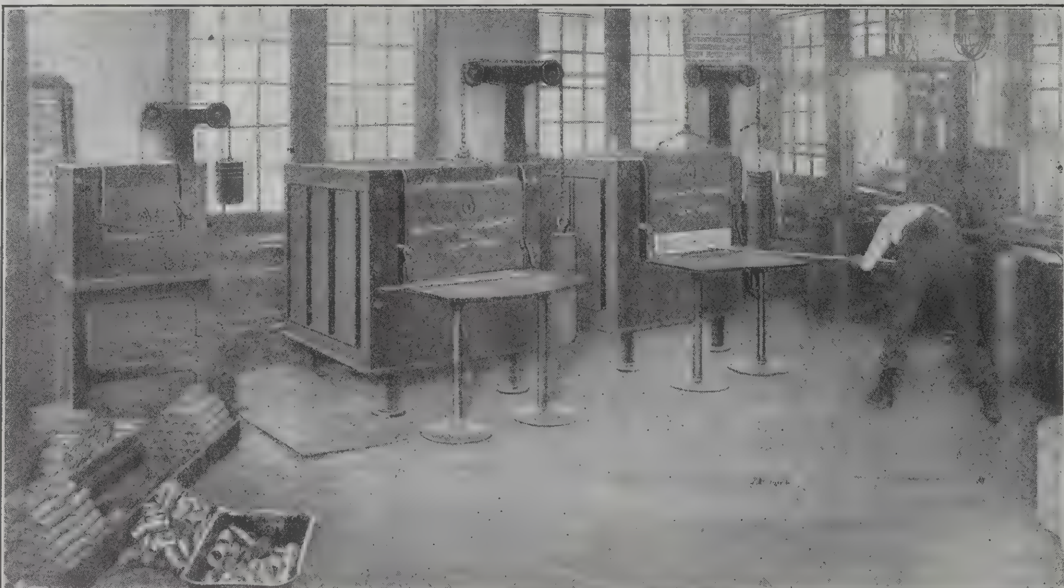
A cent today saves a dollar tomorrow. Procure your post-card and say, "Let's have your important proposition". To every astute, discerning machinist, we send it free.

SAWYER TOOL MFG. CO., FITCHBURG, MASS., U. S. A.

FURNACE FACTS

Proper heat treatment is essential where uniform product is desired, and the temperature of the furnace must be accurate and controllable, not dependent upon atmospheric conditions which interfere with stack draft, or dependent upon quality of coal or coke or the frequency of stoking.

Our Furnaces produce a uniform temperature throughout the heating chamber, preventing unequal heating and the consequent change of shape caused by one part being heated higher than another, and the resulting distortion which remains permanent causing imperfections which often prevent use after that treatment is finished.



MODERN HARDENING AND TEMPERING PLANT, NO FLUES, NO STACKS

The temperature in our furnaces may be regulated within 10° or less **to suit the specific kind of work to be done** eliminating guess work and absolutely insuring the proper degree of heat required.

Send for Bulletin "G"-11

ROCKWELL FURNACE CO., 26 Cortlandt Street, New York

Heat Tools In This Oven Furnace

The Money You Lost Last Year

through improper heating of fine steel tools, machine parts, etc., would buy you a

Stewart No. 1 Oven Furnace

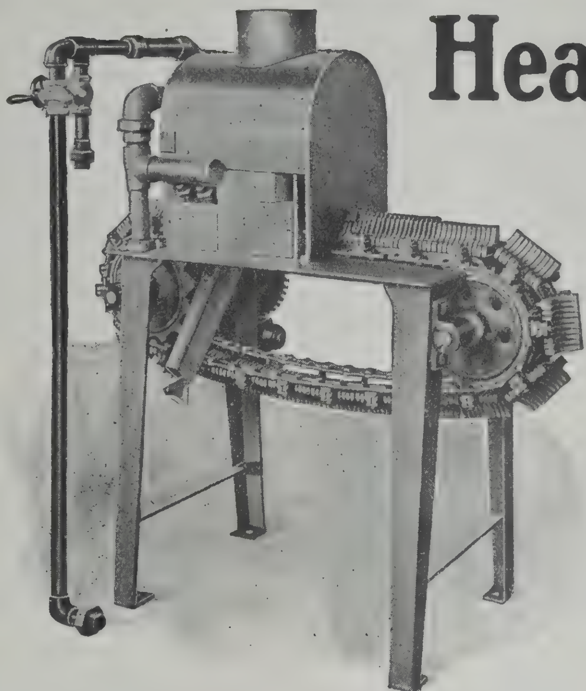
Then the loss would cease

For this furnace insures successful heating of dies, milling cutters, cutlery springs, reamers, etc. There is no chance of spoiled work.

The cost of operation is practically nothing in comparison with the saving this furnace effects, while results attained show a wonderful degree of excellence. From our 55 different styles and sizes your requirements can be exactly suited. This furnace can also be used as a Muffle Furnace. **Send for Special New Literature. It's free.**

CHICAGO FLEXIBLE SHAFT CO.
149 La Salle Ave., Chicago, Ill.

FOREIGN AGENCIES:
Chicago Flexible Shaft Co., 11 Denmark St., Charing Cross Road, London, W. C. Fenwick Freres, 21 Rue Martel, Paris, France, Agts. for France, Italy, Belgium, Spain, Portugal and Switzerland.



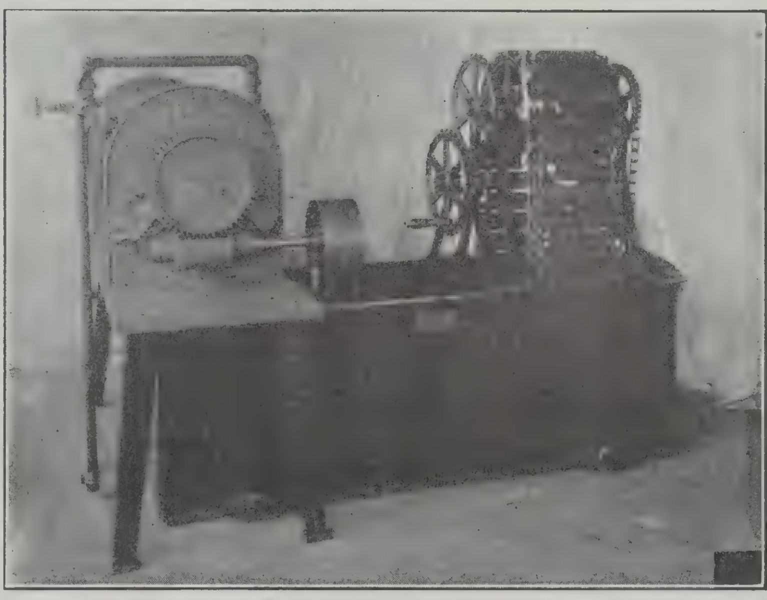
No. 60 Heating Machine

Heating Machines FOR Industrial Purposes

This apparatus is especially applicable in the manufacture of Mower Blades and other similar work requiring accurate heat treatment.

Heating Machine, in Combination with a Quenching Bath

The apparatus is especially applicable in the manufacture of ball bearings and other small work requiring very accurate treatment, and in which the quenching of the heated steel is quite as essential as the proper heating.



No. 29 Heating Machine with Quenching Bath

The principal feature of this quenching bath is that it keeps the work in motion and well separated, whereas the dropping of such work into an ordinary tank would make it liable to become bunched, retaining the heat longer than is permissible, thus producing an uneven hardening.

Blast under 1 lb. pressure to the square inch indispensable.

American Gas Furnace Company

24 John Street, New York

AGENTS: Chas. Churchill & Co , Ltd., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Paris. Cologne, Brussels, Milan, Bilbao.
Chicago, Machinists' Supply Co., 16-18 South Canal St. St. Louis, W. R. Colcord Machinery Co., 811-823 North Second St., and Gas Companies in nearly all Cities and Manufacturing Towns.

TRADE MARK W

Better Drop-forgings

We advertise "Superior Drop-forgings"!

Why?

For years there had been no certainty as to quality of steel as it entered into Drop-forgings. Then we equipped a laboratory for chemical and physical tests; eliminated the material unsuited to the customer's needs. Physically we found conditions which required special treatments—treatments with which to insure increased strength, better and longer wear. These matters we apply with intelligence—we know what you need and give it to you! Our forgings are better because they are made with a better understanding; made with greater care for better results.

Get Catalog "B-09" free.

Analysis, Carbonizing, Testing, Heat-treating, Tempering, etc., etc., done to order.

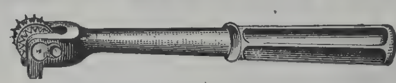
J. H. WILLIAMS & CO.
SUPERIOR DROP-FORGINGS
BROOKLYN, N. Y. CITY

Grinding Machines

Different Styles and Sizes for Floor and Bench.

EMERY WHEEL DRESSERS

No. 1 For Regular Shop Use.



No. 2 For Large Wheels.

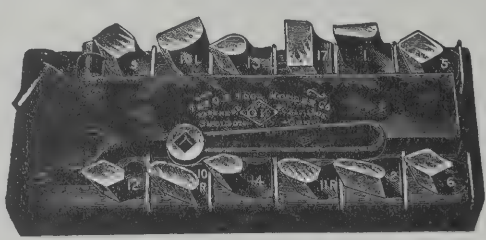
These Dressers in connection with our Cutters make a most powerful and efficient tool, espscially our No. 2 which is made proportionately larger and stronger for large wheels.

CUTTERS

We make the regular "Huntington" (pattern) Paragon Cutter and Roughing Cutters for Dresser No. 1, and the "Huntington" (pattern) and Roughing Cutters for Dresser No. 2.

Let us send you descriptive circular and prices.

GEO. H. CALDER, Lancaster, Pa., U. S. A.



Send for our new catalogue and learn how to save money on Turning Tools.

The O.K. Tool Holder Co.
SHELTON, CONN., U. S. A.

Finished Machine Keys

Cheaper than you can make them. **Finished "Ready to Drive."**

Gib and Plain Head
All sizes carried in stock.
Write for discounts.
OLNEY & WARRIN
66-68 Center St., New York

There are two ways of paying attention to little things. Getting the best of them or letting them get the best of you.

Possibly you are making a mistake if you do not use

"OXoilOX"

the perfect belt dressing—and if so it may be costly.

You cannot make any mistake by merely trying it, and such a trial will cost you nothing.

WHY NOT REMOVE THE DOUBT?

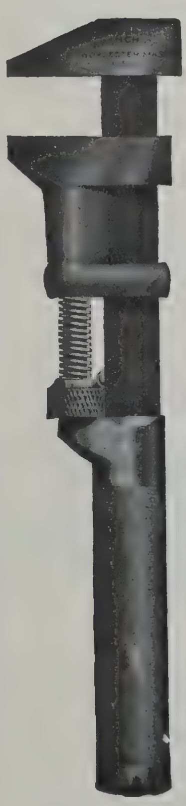
F. S. WALTON CO., Philadelphia, Pa.
PRESSERS AND REFINERS OF NEATSFOOT OIL

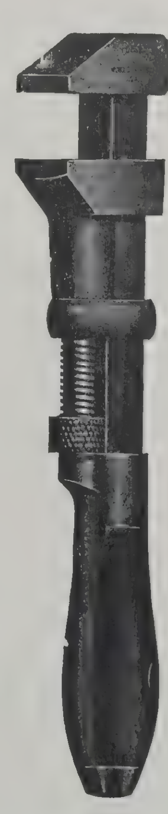
GENTLEMEN:—Kindly send us a free sample of OXoilOX Belt Dressing.
Name ....
Address ....
Employed by ....
Number of Belts .... Average size ....
Mach.

The Coes Plant at Worcester, Mass.

80 Per Cent. of the Screw Wrenches

Produced in the whole United States are made in the Coes factories. More than 85,000 dozen COES GENUINE WRENCHES finished, tested, packed and shipped each year. This immense output is required to meet the demand for high grade wrenches and the Coes Wrenches have been standard for close to 70 years. They are 30 per cent. stronger, size for size, than any other wrench made, are simple in design, well balanced, well hardened, long wearing, and are made in five styles and fifty sizes.





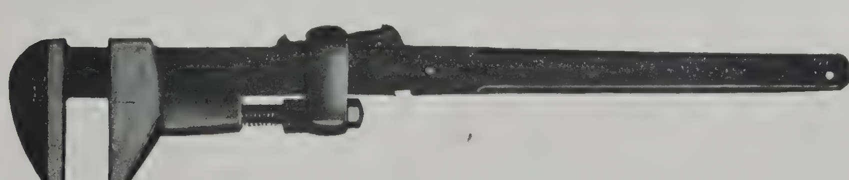
When you buy a Coes Wrench, look for the name—it is always stamped on the genuine wrench.

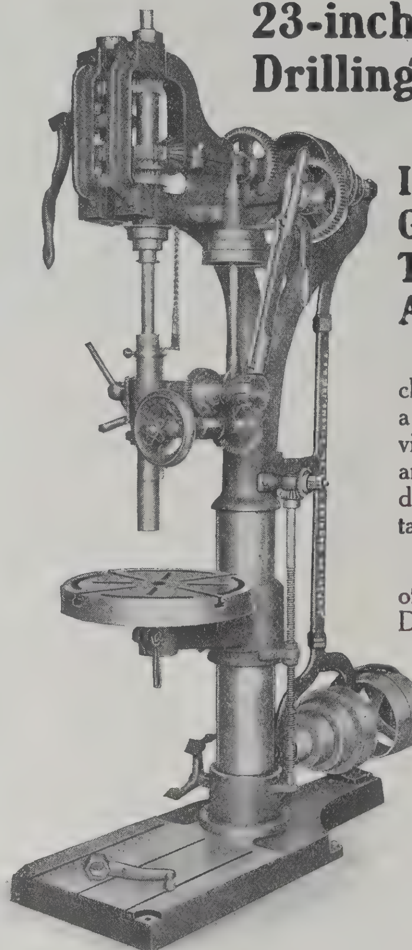
COES WRENCH CO.

WORCESTER, MASS., U. S. A.

Agents: J. C. McCARTY & CO.
21 Murray Street, New York.
438 Market Street, San Francisco, Cal
1515 Lorimer Street, Denver, Col.

Agents: JOHN H. GRAHAM & CO.
113 Chambers Street, New York.
14 Thavies Inn, Holburn Circus, London, E. C.
Copenhagen, O. Denmark.





23-inch Superior Drilling Machine

with

Improved Geared Tapping Attachment

A powerful machine which covers a wide range of service both in drilling and tapping, and under the most advantageous conditions.

Full description of our new Tapping Device on request.

The Superior Machine Tool Co.

Kokomo, Ind.

How About Your Drilling?

Can You Use Power Feed?

If increased production means anything to you, rapid handling, accuracy and economy, "get a line" on the

Barr Multiple Drills

before you go any further.

Well fitted, powerful—wide range of styles and sizes.

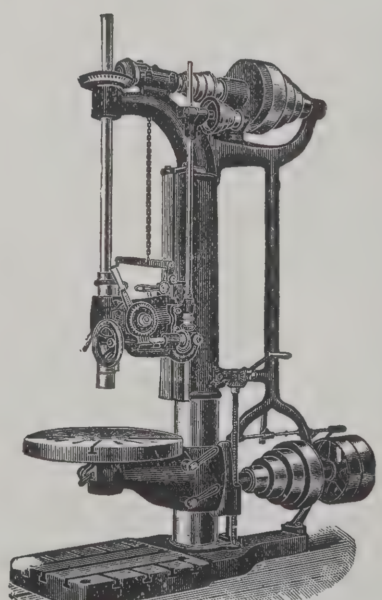
H. G. BARR, Worcester, Mass.

OUR LINE

BELT FEED
OR
"POSITIVE FEED"

- 32-in.
- 26-in.
- 24-in.
- 20-in.
- 14-in.
- 14-in. B
- 13-in. B
- Standard Drills

- No. 1
- No. 2
- Friction Drills



32-in. Drill

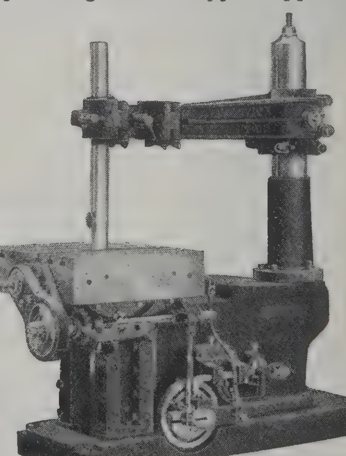
MECHANICS MACHINE CO.

19th Avenue, Rockford, Ill., U. S. A.

AGENTS: Garvin Machine Co., New York. C. W. Burton, Griffiths & Co., London. Ateliers Demoor, Brussels. R. S. Stokvis & Zonen, Rotterdam.

You can chuck 99% of the work that comes within the range of a Baker Key-Seating Machine without moving the column.

And should it be necessary to move the column the change can be made in a few minutes. The Baker machine is accurate, rapid and of simple design. The upper support not only keeps the cutter bar rigid but in perfect alignment, and makes it impossible for the cutting tool to spring away from the work. Work is quickly and easily set, stroke instantly adjusted and the powerful gears and stiff support permit the heaviest cuts to be taken. Seven sizes.



Ask for the book.

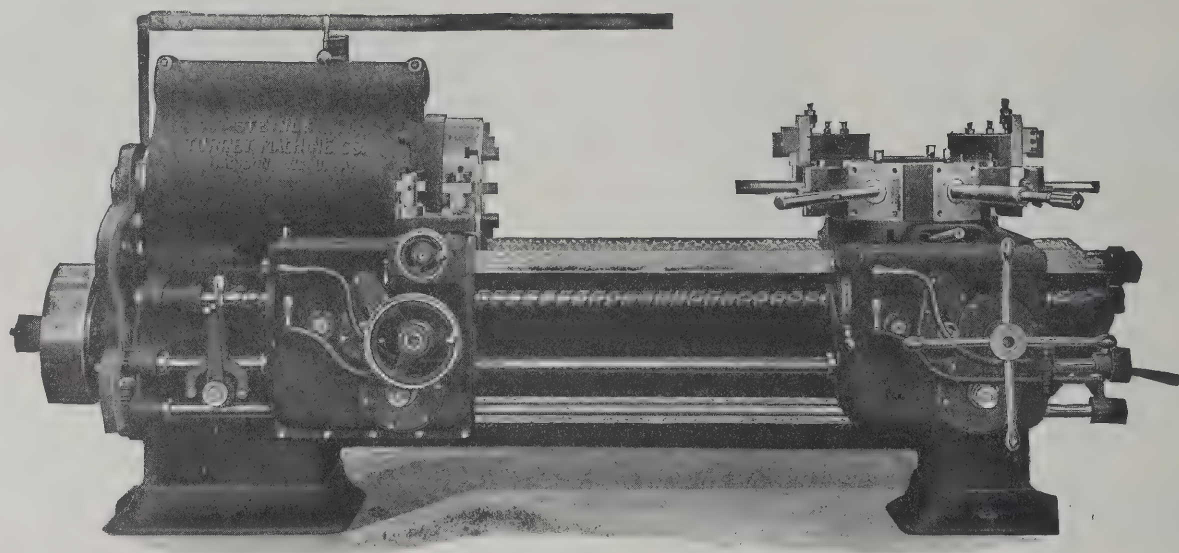
BAKER BROTHERS

Toledo, Ohio, U. S. A.

FOREIGN AGENTS: Schuchardt & Schutte, Berlin, Vienna, Stockholm. A. H. Schutte, Cologne, Paris, Brussels, Liege, Milan. Chas. Churchill & Co., London and Manchester.

THE FULL SWING TURRET LATHE

Increased Capacity - Short Turret Tools - Modern in All Details



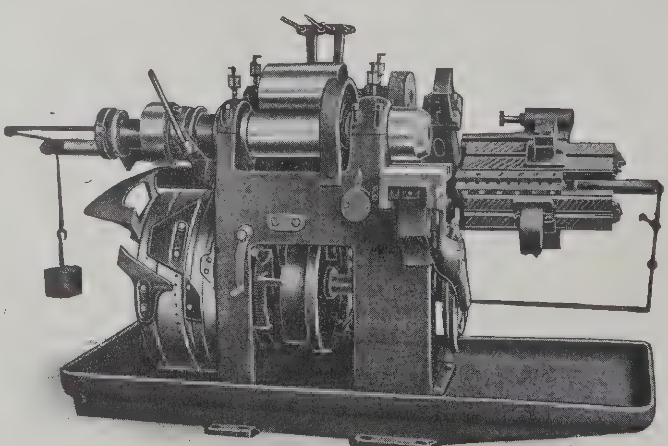
STEINLE TURRET MACHINE COMPANY

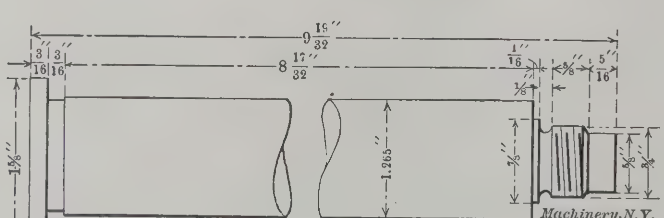
MADISON, WIS., U. S. A.

SELLING AGENTS

MANNING, MAXWELL & MOORE, Inc.,
New York.
Atlanta, Boston, Chicago, Cleveland, Detroit, Milwaukee, **Philadelphia**, **Pittsburg**, St. Louis Syracuse, Seattle, Portland, Japan, Mexico.

LUDW. LOEWE & CO., A. G.,
Berlin.
Austria, Belgium, Denmark, France, Germany, Holland, **Hungary**, Italy, Norway, Romania, Russia, Spain, Sweden, Switzerland.





The above piece of work, cold rolled steel, $9\frac{19}{32}$" in length, was turned on a 3¼ inch Gridley Automatic in 9 MINUTES.

THE ECONOMY OF A

Gridley Automatic Turret Lathe

is not only in its productive capacity—though that alone would sell the machine—but it has the advantage of not requiring an expensive outfit of tools, handles work fully twice the length of any other automatic, one man can operate several machines and the accuracy of the work turned out has never been surpassed and rarely equaled.

We shall be glad to send new catalogue and further examples of "good work."

WINDSOR MACHINE COMPANY, Windsor, Vt.

Manning, Maxwell & Moore, Inc., Sales Agents, New York, Philadelphia, Pittsburg, Cleveland, Chicago and St. Louis. M. Koyemann, Charlottenstrasse, 112 Dusseldorf, Germany, Holland, Belgium, Switzerland and Austria-Hungary. Craven Bros., Ltd., Manchester, Great Britain and Colonies and South America.

KEMPSMITH
UNIVERSAL MILLING MACHINES

Ideal for Tool Room and General Service

ALL feeds positive and automatic, with very liberal range.

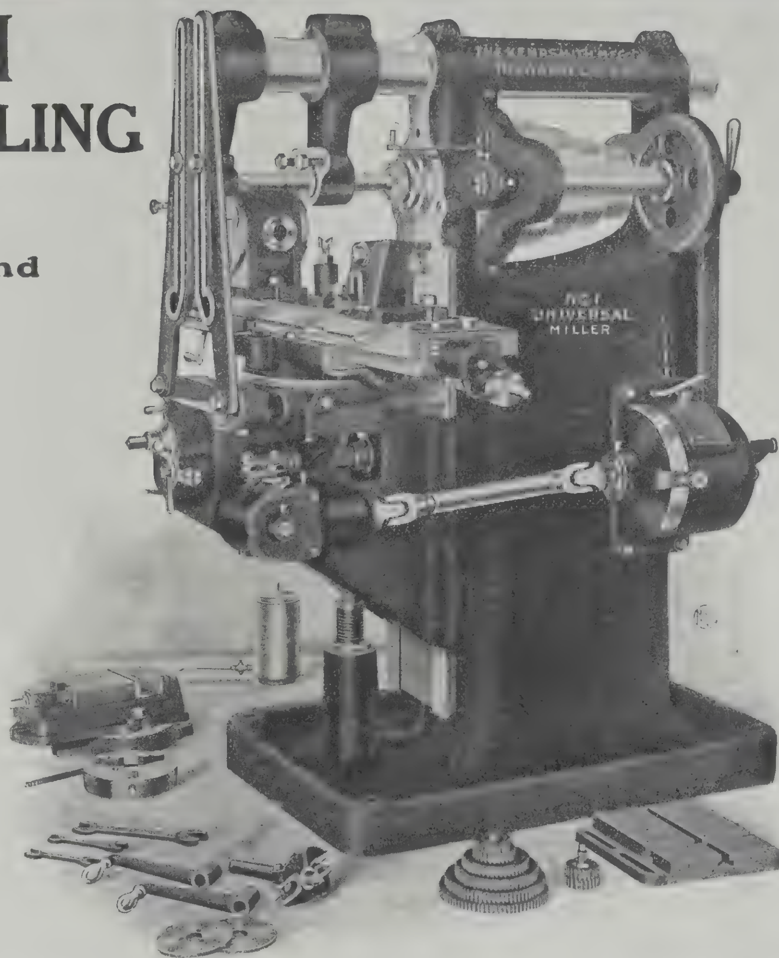
ALL feed changes obtained instantly through *one* box only, while machine is *operating under cut.*

ALL table feeds controlled by *one* lever at front of knee.

Swivel table rigidly clamped at any angle through *one* screw only.

Simplicity and *convenience* in its entire operative mechanism are of great value in general milling.

Guaranteed accuracy in every alignment and powerful construction and liberal weight.



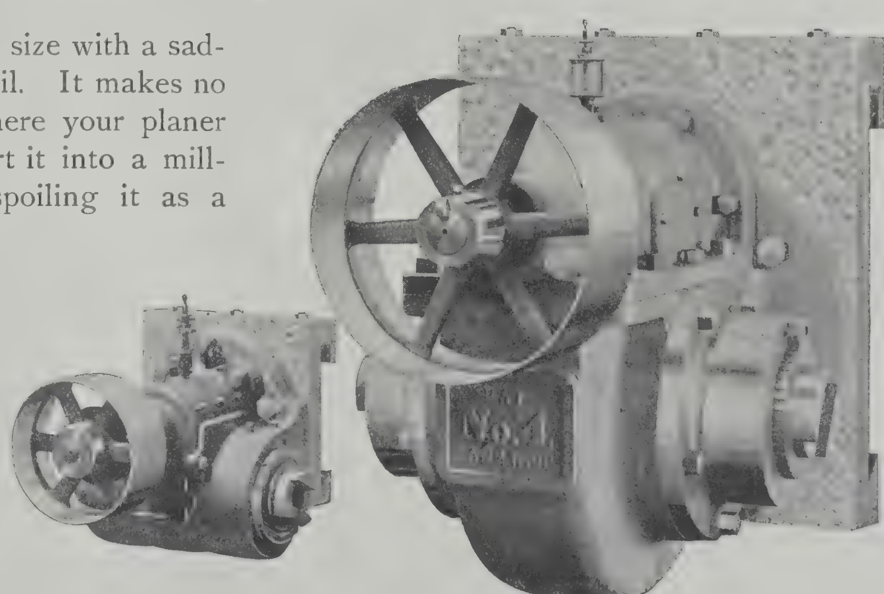
KEMPSMITH MFG. CO.
MILWAUKEE, WIS.

European Agents: Selig Sonnenthal & Co., London, E. C., England.
Canadian Agents: London Machine Tool Co., Ltd., Hamilton, Ont.

Farwell Milling Attachments

can be obtained in any size with a saddle to fit any planer rail. It makes no difference when or where your planer was built we can convert it into a milling machine without spoiling it as a planer.

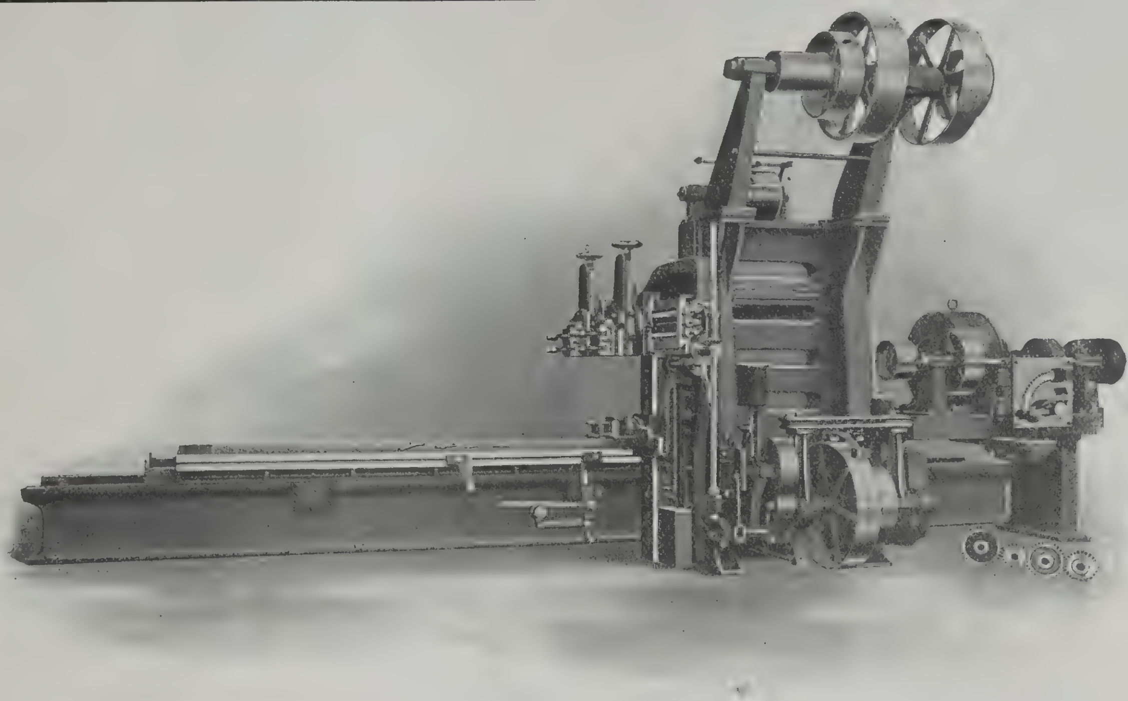
The head can be swivelled to any position and we make special saddles to fit special jobs. We also have a revolving table which enables you to hob worm wheels on the planer.



Catalog 56-M shows how it is done.

THE ADAMS COMPANY, 617 White St., **Dubuque, Iowa, U.S.A.**

AGENTS—De Fries & Co., Dusseldorf, Germany. G. Koeppen & Co., Moscow, Russia. J. Lambercier & Co., Geneva, Switzerland. V. Lowener, Copenhagen, Denmark. Aktiebolaget V. Lowener, Stockholm, Sweden. Glaenzer, Perreaud & Thomine, Paris, France. Ducas & Co., Vienna, Austria, Budapest, Hungary. Manning, Maxwell & Moore, Yokohama, Japan.



THE OPEN SIDE PLANER with Variable Speed Motor Drive.

Standard sizes: 30", 36", 42" 48", 60" and 72".

THE DETRICK & HARVEY MACHINE CO., Baltimore, Md.

Makers of

Horizontal Drilling, Boring and Milling Machines

FOREIGN REPRESENTATIVES:—Ludw. Loewe & Co., Berlin, Germany. Paul Auriol, Paris, France. Wilh. Sonesson & Co., Malmo, Sweden. Chas. Churchill & Co., London, England.

WE MAKE IT

Write for catalog

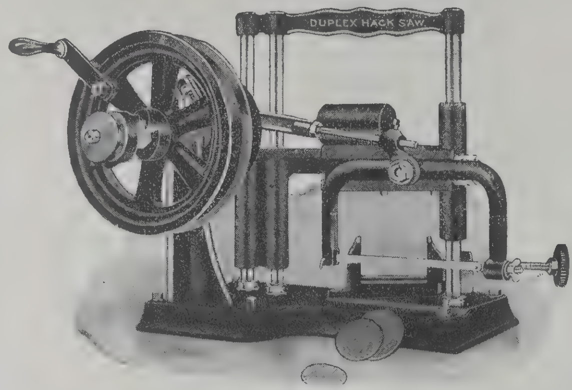
RACK

Pacific Tool & Supply Co.
San Francisco, Cal.

Hall & Pickles
64 Port St., Manchester, Eng.

Seattle Hardware Co.
Seattle, Washington

Duplex Hack Saw on 15 Days' Trial



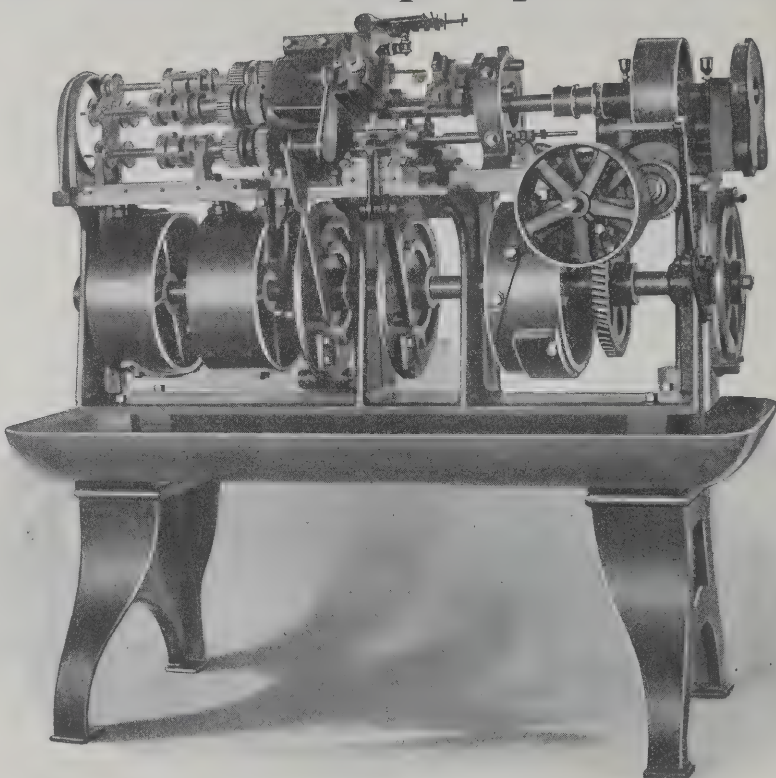
We will ship you this Duplex Hack Saw on 15 days' trial, with the privilege of returning at our expense if you do not find it to cut rapidly and absolutely square. This is the best hack saw on the market for most uses.

Very easy to operate by hand on account of large fly wheel which gives both momentum and steady movement. Saves saw blades.

Can be quickly attached to any belt when power is desired, large fly wheel serves as a pulley. *Correspondence invited.*

Buffalo Specialty Co., 420 Ellicott St., Buffalo, N. Y.

The Universal Multiple Spindle Automatic Screw Machine



For Screws and Screw Work of every description.

Send us your specifications for steel, iron or brass screws—any shape or size—and let us estimate the cost produced on the universal.

Our machines are powerfully driven by one straight belt from the countershaft; have a gear driven threading mechanism which permits different speeds for various sizes and kinds of stock, and perform ten operations in the same time required by the ordinary machine to complete the longest single operation.

The height of perfection and economy in screw work.

THE UNIVERSAL MACHINE SCREW COMPANY, Hartford, Conn.

DOMESTIC AGENTS: Prentiss Tool & Supply Co., New York, Boston, Buffalo. Brown & Zortman Machinery Co., Pittsburg, Pa. Marshall & Huschart Machinery Co., Chicago, Ill.

Nicholson's Expanding Mandrels

save time and money. While a man is hunting through a lot of solid mandrels to get one of the right size for the job in hand, the work could be half done with a Nicholson Expanding Mandrel. Isn't this worth looking into?

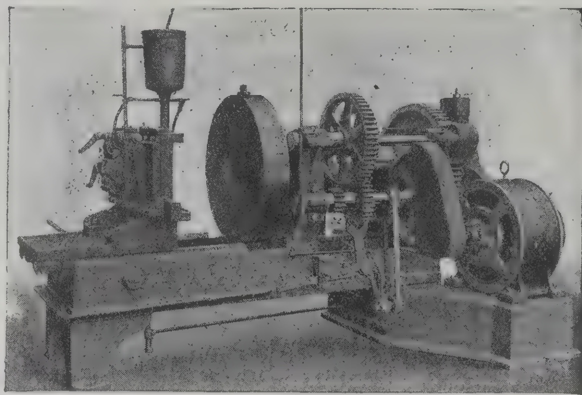
Made in sets of nine; fit any sized hole from 1 to 7″. Strong, durable tools; compact and convenient; all parts interchangeable. Always ready, always right.

Our Catalogue tells more about them.

W. H. Nicholson & Company

WILKES-BARRE, PA., U. S. A.

FOREIGN HOUSES—C. W. Burton, Griffiths & Co., London Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm, St. Petersburg.



Westinghouse Motor Driving Cox Pipe Threader.

There is not a machine a Westinghouse Motor cannot drive.

Westinghouse Motors are made in such a variety of sizes and types, for operation on either direct or alternating current circuits, that there is not a machine now in use that cannot be driven more satisfactorily and economically by a Westinghouse Motor, than by any other means. Our engineers have devoted years to studying the motor requirements of a large number of machines; their knowledge is at your service. Send us your motor-drive problems for solution.

Ask for Folder No. 4132.

Westinghouse Electric & Mfg. Co.

Sales Offices in all large Cities. Pittsburgh, Pa.

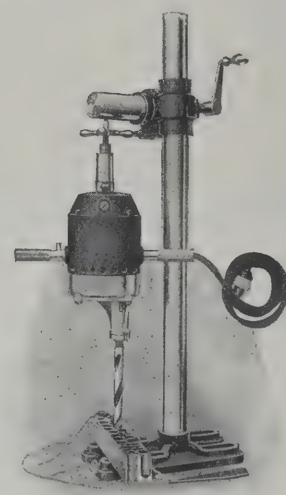
Buy an Improved "Hisey" Electric Drill or Grinder

And Eliminate Repair Bills.

All Motors Air Cooled.

Let us ship you a machine on ten days' trial.

Immediate Delivery.

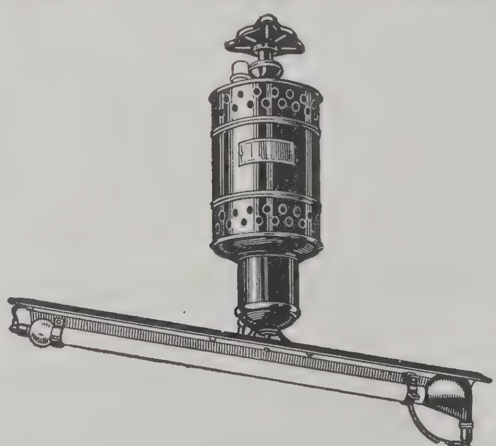


Catalog No. 7.

Hisey-Wolf Machine Company

New York Office: 50 Church St. **CINCINNATI, OHIO**

Cooper Hewitt Lamps



The Cooper Hewitt Lamp is free from glare

inexpensive in first cost, requires little attention and is highly economical of current. Not only is it free from injurious glare, but is a positive assistance to vision. Those using it have frequently been able to discontinue the use of glasses. Think this over carefully then—investigate.

See Catalogue No. 90.

Cooper Hewitt Electric Co.

220 West 29th St., New York

Albany, N. Y. . . . . 66 State St.	Detroit, Mich. . . . Prud. Life Bldg.
Boston, Mass. . . . 161 Summer St.	Minneapolis, Min. . . Majestic Bldg.
Chicago, Ill. . . . 40 Dearborn St.	Philadelphia, Pa. . . 124 So. 8th St.
Cincinnati, O. . First Nat'l Bank Bldg.	Pittsburg, Pa. . . . Wabash Bldg.
Cleveland, O. . . . . American Trust Bldg.	

A Motor for Real POWER ECONOMY

You wouldn't hire six men to do the work that two could do with ease. Yet perhaps you continue to use six horse power to drive a distant machine, by old line-shaft methods, that only requires about two horse power when driven by one of our adjustable speed motors.

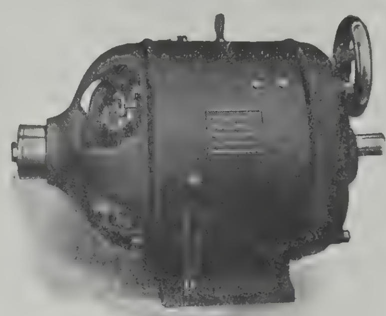
FORT WAYNE MOTOR DRIVES

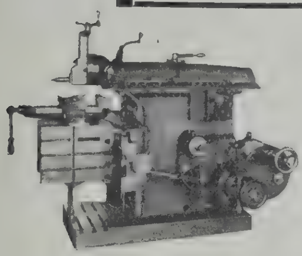
eliminate friction losses -- provide wide speed adjustments -- allow you to locate machines where work is -- increase the output and cut in half the cost of operation.

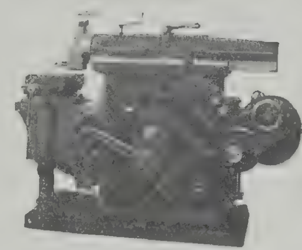
We have a bulletin 1416 on this subject that contains a lot of mighty valuable information and we want to send one to you. Write for it now.

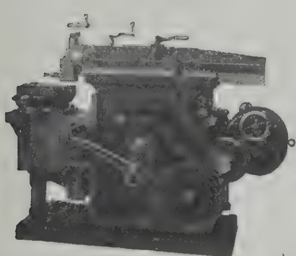
Ft. Wayne Electric Works

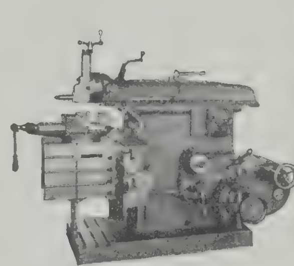
Ft. Wayne, Ind.

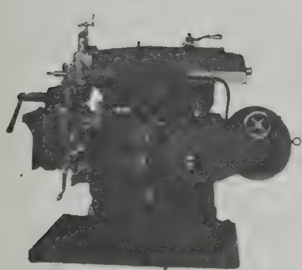


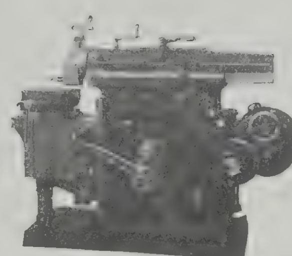


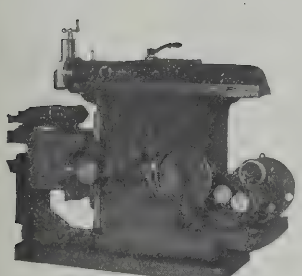


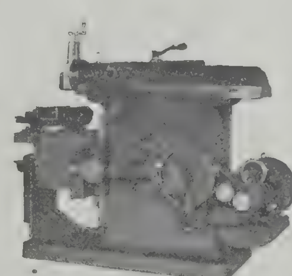


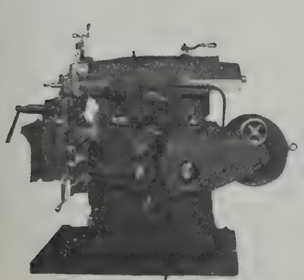












Lincoln Variable Speed Motors will make your Shapers do 20 to 100% more work.

It's simply a question of cutting strokes per minute plus ample power at the cutting tool.

Do you realize that with only eight changes in cutting strokes whether these are obtained by means of a speed box or cone pulleys, whether the source of power is a main line shaft or a constant speed motor, the average capacity of any shaper doing miscellaneous work under the best conditions *cannot be greater than 84% of its possible maximum* and under average conditions is usually less than 50%? Extensive tests have proved this.

The Ideal Drive

The following conditions *must* be met to produce 100% productive efficiency from any shaper under all conditions:

1. A positive method of drive which delivers *full power at all speeds.*
2. A proper range of speeds.
3. An *unlimited* number of running speeds.

You get *all* these with the *Lincoln Variable Speed Motor.*

It is the *only* motor which gives an *infinite number* of running speeds throughout wide ranges,—there is absolutely no jump or gap, the speed change being smooth, gradual and continuous.

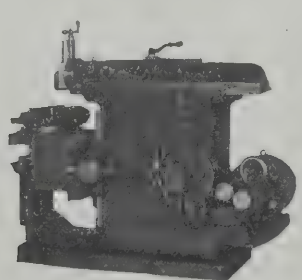
This is all accomplished simply and quickly—*No complicated controller is required.*

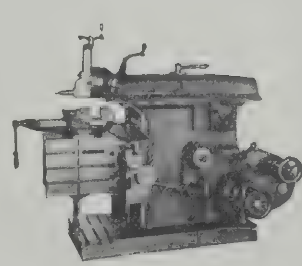
Whatever make of shaper you buy select a Lincoln Variable Speed Motor to drive it.

If you would be interested in learning more about this wonderful motor, ask us to send Bulletin 10-M.

Our Bulletin 101 "The Crank Shaper" takes up the shaper drive question thoroughly,—it gives some interesting facts and figures, the results of careful tests.—Shall we send it?

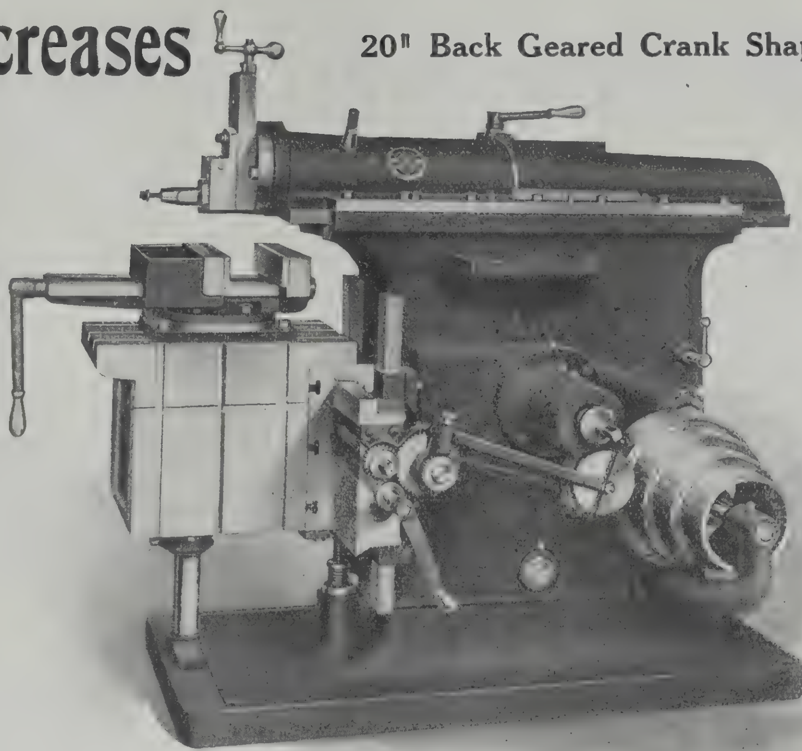
Reliance Electric & Engineering Co.
800 Huron Road Cleveland, Ohio





Convenience Increases Production

20" Back Geared Crank Shaper



In addition to strength, rigidity and extra long shaft bearings the "Rockford" excels in convenience of operation. Adjustments can be quickly and easily made and all levers are on the working side of the machine.

A "Rockford" Shaper will increase production, reduce labor costs and insure accurate work.

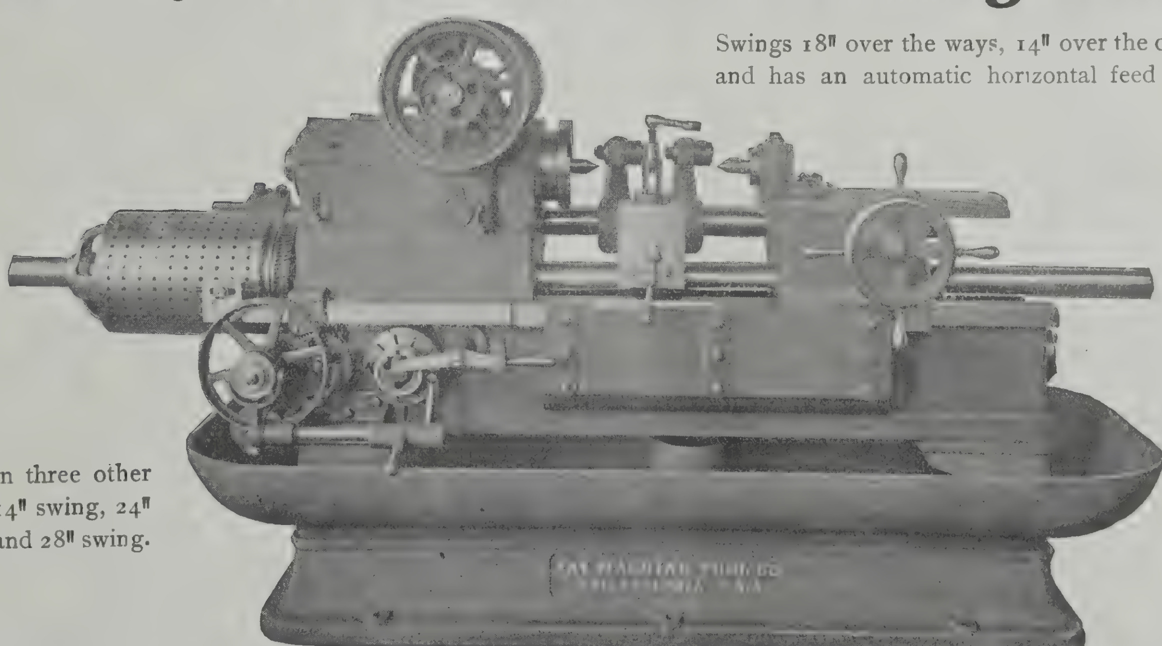
Four sizes, 14", 16", 20" and 24". Send for descriptive circular.

We also build the Rockford Planers 24", 28", 32" and 36" sizes.

ROCKFORD MACHINE TOOL COMPANY
ROCKFORD, ILL., U. S. A.

The Fay 18" Automatic Turning Lathe

Swings 18" over the ways, 14" over the carriage, and has an automatic horizontal feed of 12".



Made in three other sizes, 14" swing, 24" swing and 28" swing.

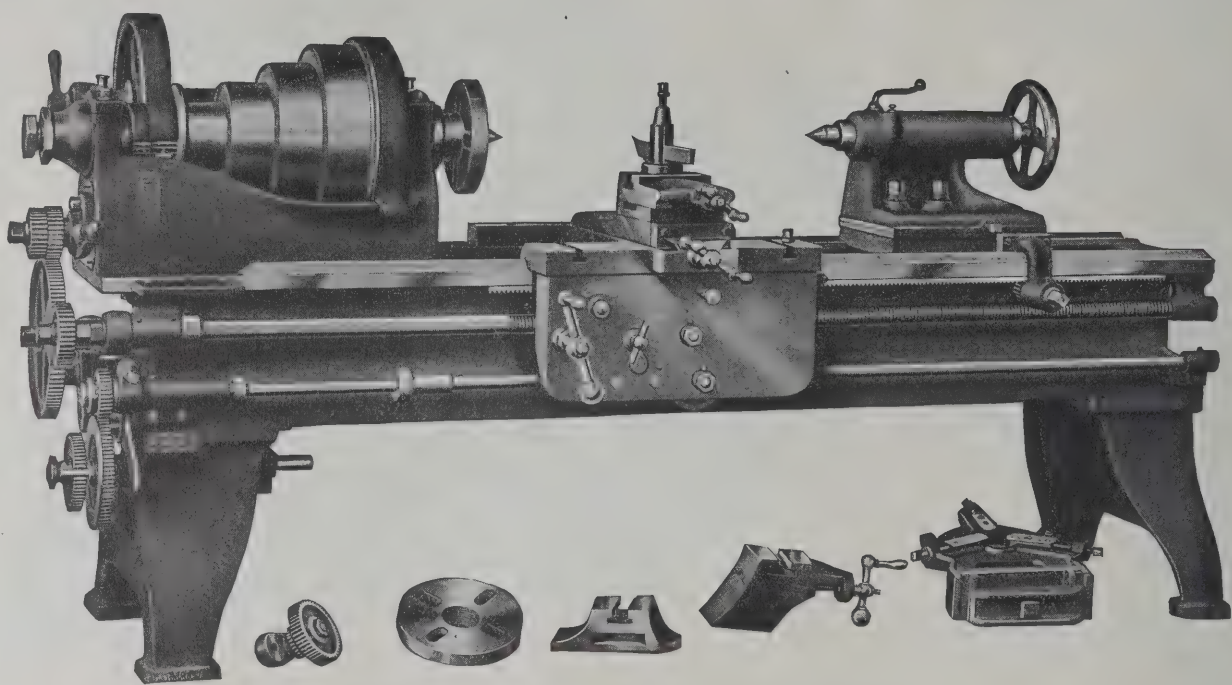
Spur gears, bevel gears, feed cones, ball bearings, roller bearings, etc., are *manufactured* on the Fay lathe, as all feeds are automatic, and one man can run from 4 to 6 lathes.

Watch our advertisements in the future for samples of work done and time it took to turn them. Bulletin for the asking.

FAY MACHINE TOOL CO., Philadelphia, U. S. A.

FOREIGN AGENTS: Great Britain, C. W. Burton, Griffiths & Co., Ludgate Square, Ludgate Hill, London, E. C.; Germany, Switzerland and Austria-Hungary, Heinrich Dreyer, Kaiser Wilhelmstrasse 1, Berlin, C 2; France and Italy, Edgar Bloxham, 12 Rue de Delta (1Xe), Paris; Belgium and Holland, Stokvis & Zonen, Rotterdam.

The Individuality of the Reed Lathe



Lathes—10-inch to 30-inch.

DON'T get the idea that our lathes are the "peas in a pod" kind of product. They are alike on one point, Quality—the time-tried "Reed" Quality—but apart from that every lathe has as much individuality as the man who uses it.

It couldn't be otherwise in the output of a plant where every man is trained for his work; he can't help but put some part of himself into the machine he builds, and it's this special workmanship that gives the Reed Lathe an intangible but distinct individuality. A Reed Lathe is as good a workman as the workmen who built it—and they could not be better.

You can depend on the Reed, also, to fill every requirement. There is nothing experimental about them, they have made their mark, proved their metal and gone into the "none better" class. 24,000 Lathes built and sold in twenty-seven years is something of a record. The fact that individual Reed Lathes built more than twenty years ago and in constant service ever since, are still holding up their end of the work in a busy shop, is more of a record. Glad to add details if you'll write us.

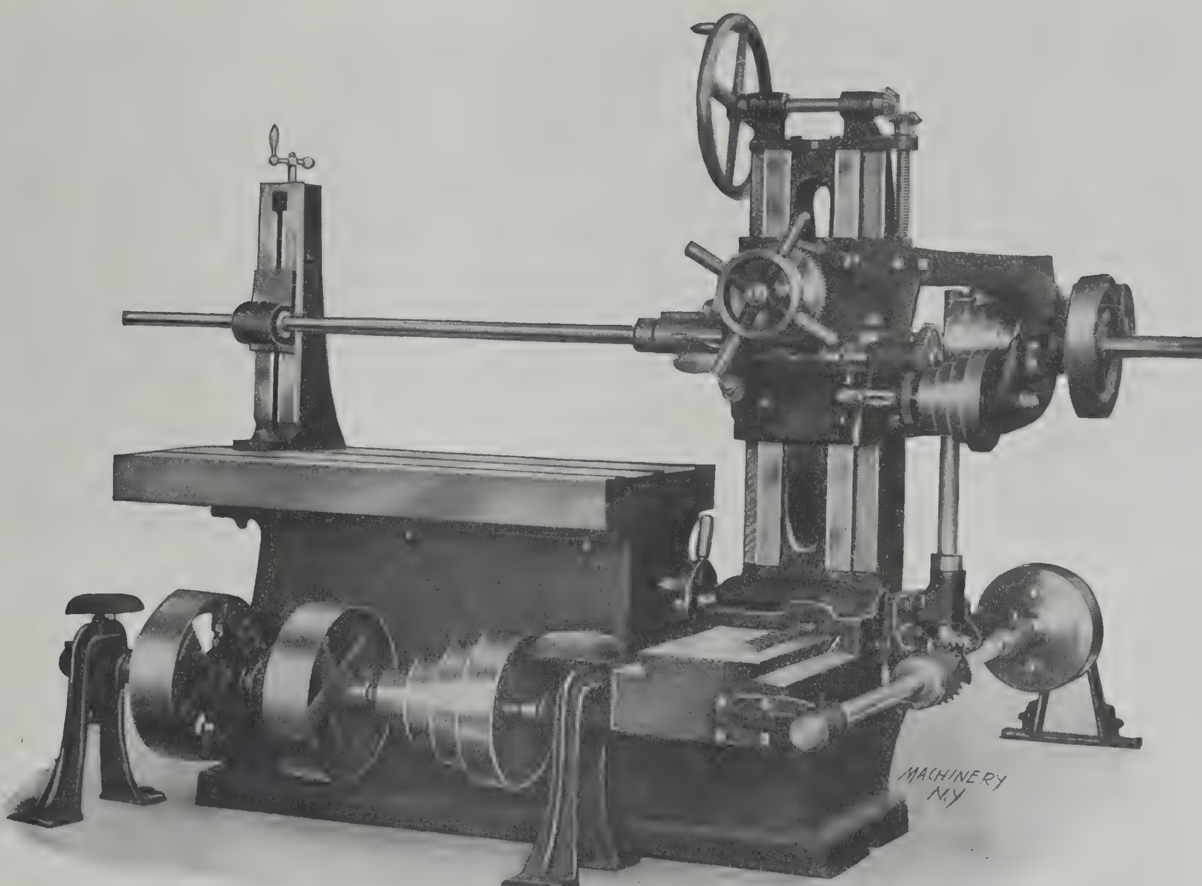
F. E. REED CO., Worcester, Mass.

SELLING AGENTS—**MANNING, MAXWELL & MOORE, Inc., 85-87-89 Liberty St., New York, N. Y.**

111-115 No. Canal St., Chicago, Ill. Merrill Building, Milwaukee, Wis. Kirk Building, Syracuse, N. Y. White Building, Buffalo, N. Y. Cor. Oliver & Franklin Sts., Boston, Mass. Frisco Building, St. Louis, Mo. Atlanta, Ga., Candler Building. Indianapolis, Ind., Ter. Trac. Building. 721 Arch St., Philadelphia, Pa. Majestic Building, Detroit, Mich. San Francisco, Cal., Monadnack Building. 1262 Ontario St., Cleveland, O. Park Building, Pittsburgh, Pa. Mexico City, Mexico. Yokohama, Japan.

Thomas & Lowe Machinery Co., Providence, R. I. Syracuse Supply Co., Syracuse, N. Y. Chas. A. Strelinger Co., Detroit, Mich. Fenwick Freres & Co., Paris, France. Chas. Churchill & Co., Ltd., London, Eng. The A. R. Williams Machinery Co., Ltd., Toronto, Ont. Van Reitschoten & Houwens, Rotterdam, Holland. G. Koeppen & Co., Moscow, Russia. C. & J. W. Gardner Co., St. Petersburg, Russia. Graham Bros., Stockholm, Sweden. F. G. Kretschmer & Co., Frankfort, a. M., Germany.

The Rockford Horizontal Drilling Machine



Every little while you come up against a drilling job that can't be readily handled on an upright or radial drill. Drilling the ends of shafts, columns or other long pieces, for instance, is hardly the province of either of these machines, but the No. 2 Horizontal Drilling Machine has the power, rigidity and full capacity for just such work. The stationary table is 24-inch by 60-inch, feeding mechanism located on the saddle, all clamping levers and adjusting wheels convenient to the operator's hand. The machine is adapted for drilling, tapping, boring, facing, reaming and similar operations and is especially useful in the automobile shop. The substantial construction assures durability and continued accuracy, its versatility a wide range economy.

Ask us for complete details. We also build the Rockford Gang Drills and the new Rockford Patented Geared Tapper.

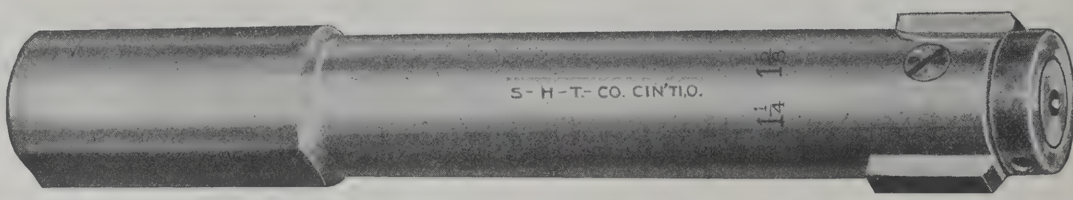
THE ROCKFORD DRILLING MACHINE Co. ROCKFORD ILL U.S.A.

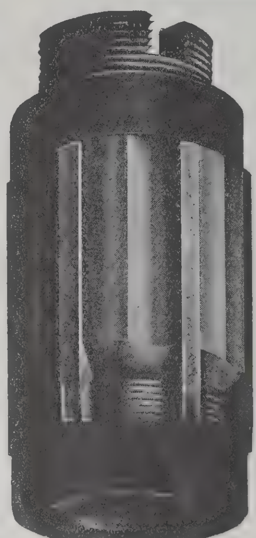
Rockford Drilling Machine Co.

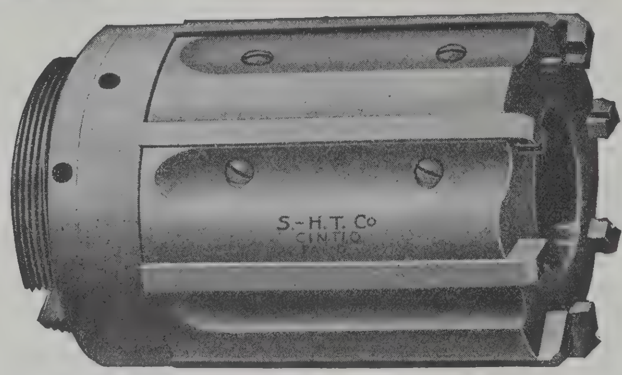
ROCKFORD, ILL., U. S. A.

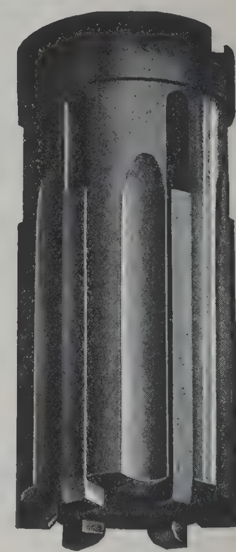
Edgar Bloxham, Agent for France, Italy and Belgium; Thomas McPherson & Son, Melbourne; Alfred H. Schutte, Agent for Western Germany, Switzerland, Spain and Portugal; R. S. Stokvis & Zonen, Ltd., Rotterdam, Agents for Holland and the Dutch Colonies.

UNIVERSAL ADJUSTABLE TOOLS









The universal adjustable cutter boring heads and reamers make an ideal combination for standardizing holes economically. The boring heads are furnished with high speed steel cutters. They are quickly and accurately adjusted, permitting a close maintenance to size. The large range of adjustment allows one tool to be used for a number of sizes either standard or fractional. The reamers are furnished with either carbon or high speed steel blades as ordered.

"Ask the man in the shop" Catalogue upon request.

The Schellenbach-Hunt Tool Co., Cincinnati, Ohio

The American Specialty Co., Chicago, Ill., Agents for the Chicago District

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, England. Markt & Co., 193 West St., New York, Germany and Italy. New York Export & Import Co., 133-137 Front St., New York, China, Japan and Australia. Williams & Wilson, Montreal, Canada. J. S. Cock, Christiania, Norway.

Van Dorn

Type "A" Lockers

Steel Lockers
for
Shop
Factory
or Office

Sheet Metal
Woven Wire
or
Expanded Metal

Catalog on Request.

THE VAN DORN IRON WORKS CO.

METALLIC FURNITURE DEPARTMENT

CLEVELAND, OHIO

CHICAGO	BOSTON	NEW YORK
410 Monadnock Block	313 Oliver B'l'd'g.	Room 205-5-A 1 Madison Avenue

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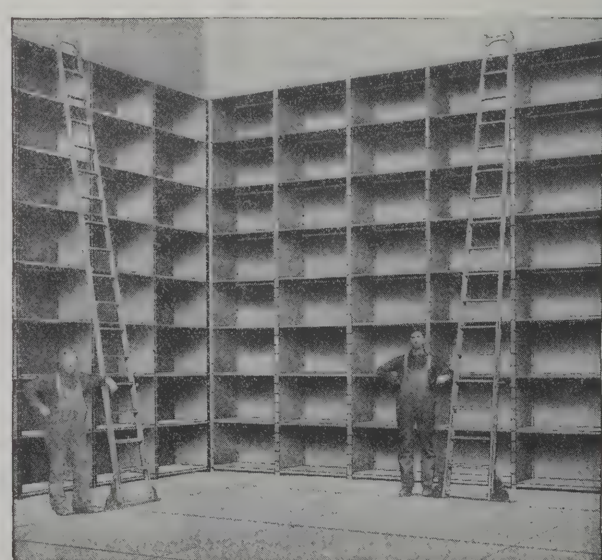
STEEL EQUIPMENT

RACKS AND BINS, TRUCKS AND BOXES
STEEL LOCKERS



The best and most economical Racks.

WHY?

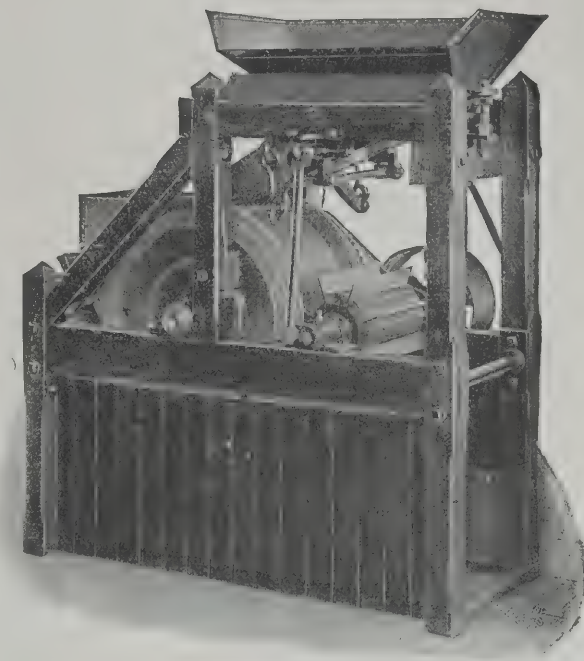
Strongest and simplest adjustment, greatest carrying capacity; suitable for the largest variety of requirements.

Save space and labor.

TERRELL'S EQUIPMENT COMPANY

NORTH GRAND RAPIDS, MICH.

The General Electric Magnetic Separator



THIS machine is used in brass foundries to remove all iron from scrap before melting; also is used in machine shops in separating magnetic from non-magnetic turnings, chips, etc.

The mixture of metal is placed in the hopper at the top of the separator and falls onto the surface of a revolving brass drum, within which an electro magnet is so arranged that it retains the magnetic metal on the surface of the drum until it is scraped off mechanically into the bin. The non-magnetic metal falls into another bin.

Rated capacity, 600 pounds per hour; maximum capacity, 900 pounds per hour.

Electro magnet requires about 75 Watts, and may be wound for 110, 220 or 500 Volts, D.C.

MANNING, MAXWELL & MOORE

INCORPORATED

85-87-89 LIBERTY STREET, NEW YORK, N. Y.

111-115 No. Canal St. CHICAGO — 721 Arch St. PHILADELPHIA — 45 Oliver St. BOSTON — Frisco Bldg. ST. LOUIS — Park Bldg. PITTSBURG — 1262 Ontario St. CLEVELAND — Monadnock Bldg. SAN FRANCISCO, CAL.

1503 Candler Bldg. ATLANTA — Traction Terminal Bldg. INDIANAPOLIS — White Bldg. BUFFALO — Majestic Bldg. DETROIT — Merrill Bldg. MILWAUKEE — Yokohama JAPAN

A Filing System for Stock

What would it mean to you to have your stock arranged as handily as your correspondence?—

In lowering production costs, time saving and labor saving devices are half the battle—the proper utilization of space is likewise a factor.

We offer you the chance to store, care for and classify your finished stock, raw materials, tools, machine parts, etc., as you do your letters. Our system is as convenient, accessible and flexible as the letter filing system in your office.

Lyon Steel Racks

solve the storage problem. The strongest racks on the market. Constructed on the right principle, built to carry uneven loads, and arranged on the unit system for any space and for any purpose.

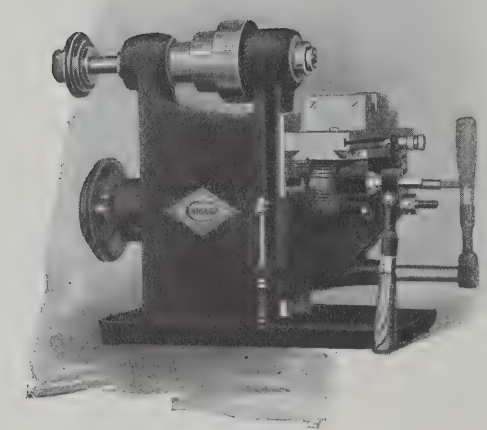
We have several Catalogues showing the varied applications of Lyon Steel Racks—and we would be glad to figure on your requirements.

CONVENIENCE, COMPACTNESS, CAPACITY AND STRENGTH.

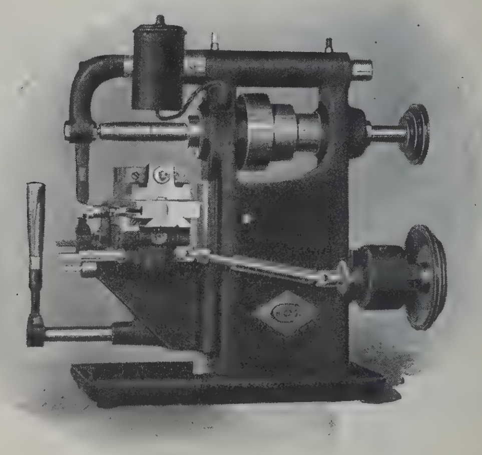
Lyon Metallic Mfg. Company

AURORA, ILLINOIS

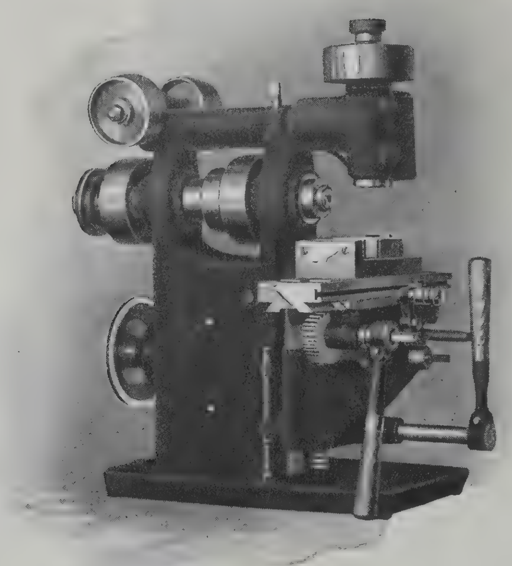
Steel Racks, Lockers and Factory Equipment.



Chicago Bench Miller



No. 1 Machine on Bench, with Overhanging Arm



No. 1 Machine on Bench showing Vertical Spindle

Chicago (Duplex) Hand Millers

With Self-Oiling Bearings

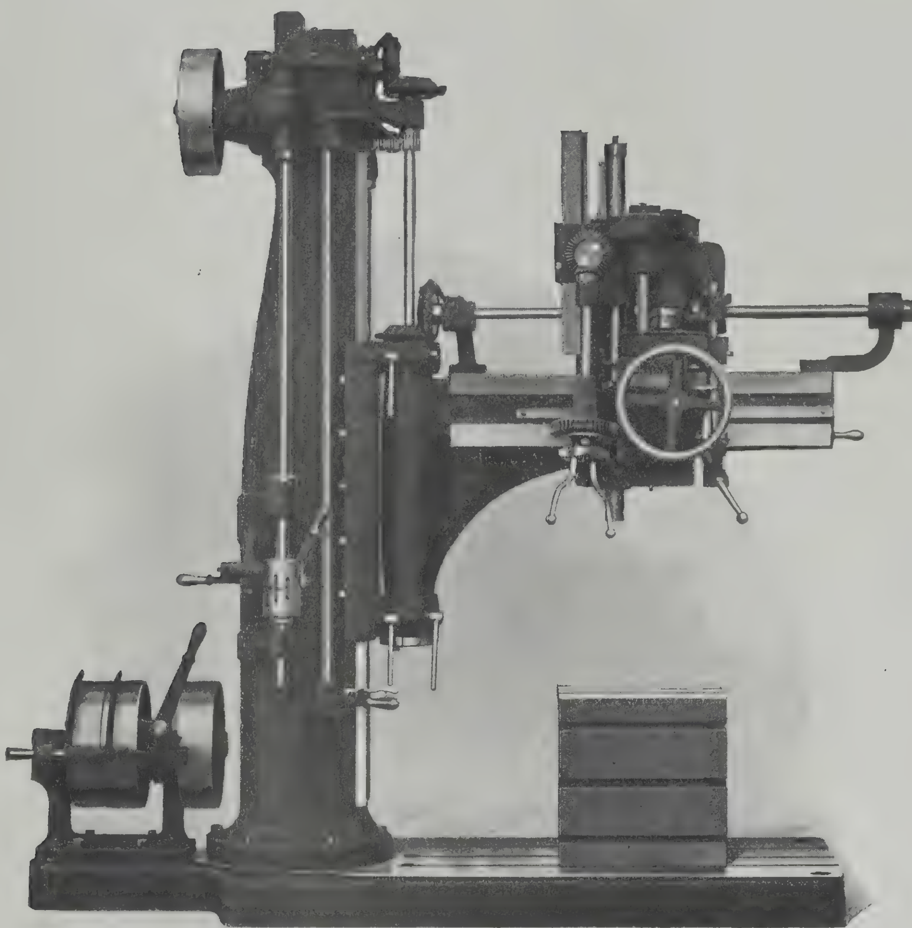
In the above engravings are shown three equipments of the Chicago Hand Miller for use on the bench. These machines have an exceptionally large range, and the combination of both vertical and horizontal spindles adapt them for the rapid production of a large variety of work.

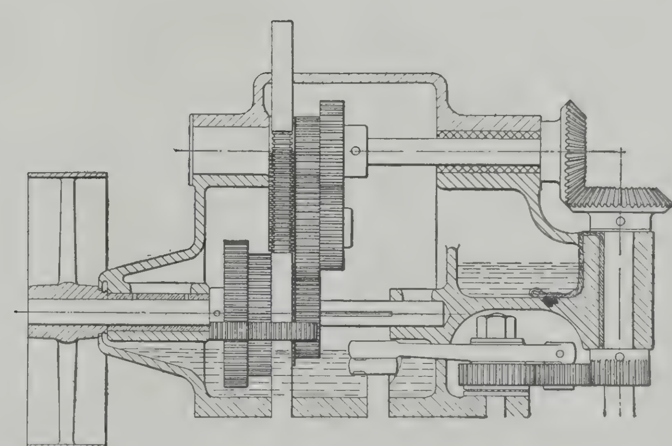
Chicago Machine Tool Co., Chicago, Ill.

Distributors

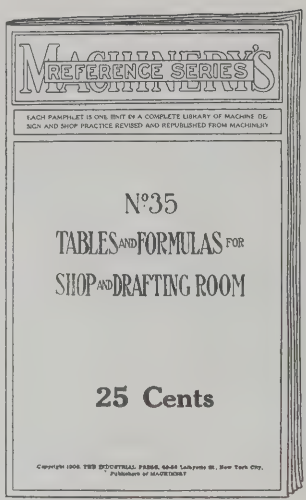
HILL, CLARKE & CO., Inc.

Boston New York Cleveland Philadelphia Chicago





MACHINERY'S REFERENCE BOOKS



The Reference Series was originated by MACHINERY and announced in the publication for the first time on January 1, 1908. Their success was instantaneous, and nearly 200,000 copies of the books have been sold to readers in machine shops and metal-working plants everywhere. The plan comprehends an indefinite number of compact units, each covering one subject thoroughly in the practical manner characteristic of MACHINERY, and sold singly, or in complete sets, as may be desired. The whole series comprises a complete working library of authentic mechanical literature for the Mechanical Engineer, the Master Mechanic, the Designer, the Machinist and the Toolmaker.

The information contained in the books of this Reference Series is the very best that has been published on machine design, construction and operation during the past fourteen years, revised and brought up to date by MACHINERY's staff—men constantly in touch with the best sources of information and with the latest developments in mechanical practice.

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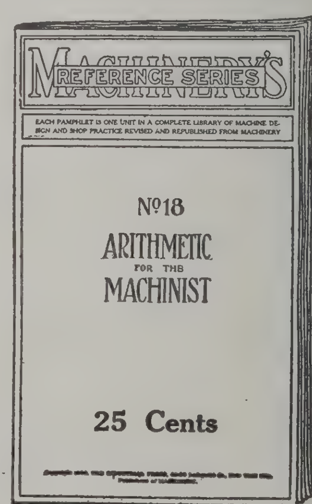

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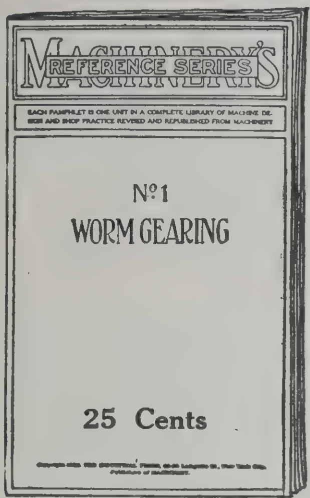

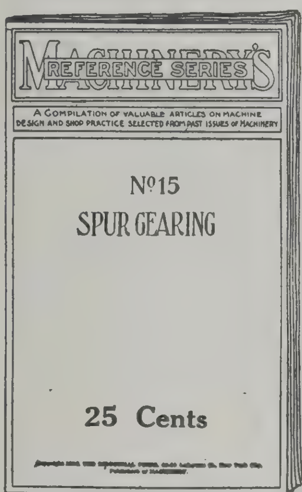

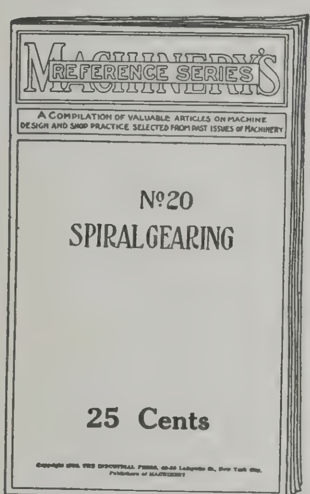

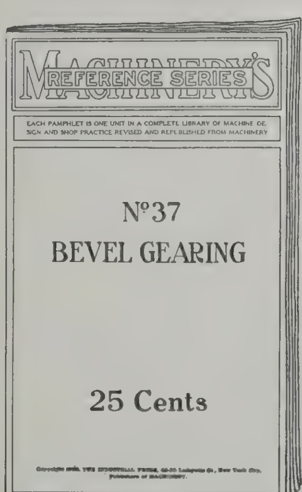

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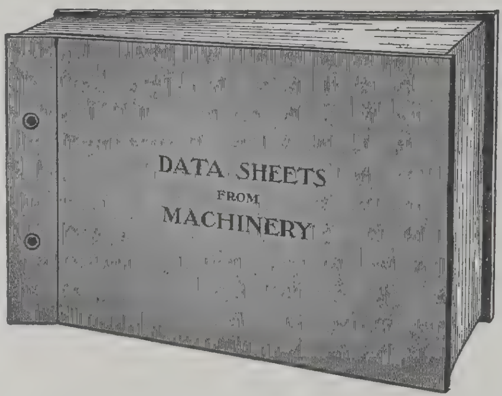

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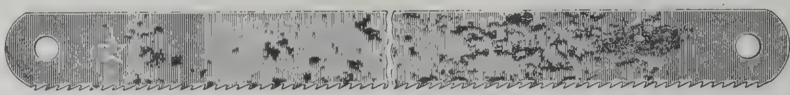

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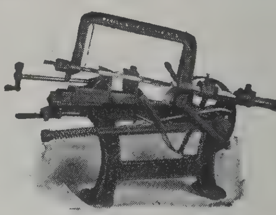

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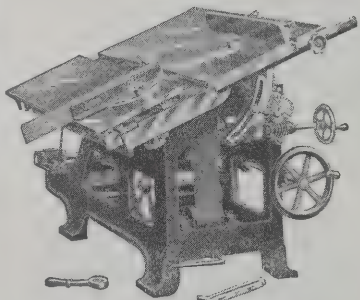

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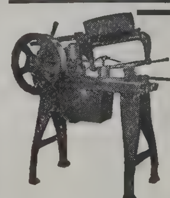

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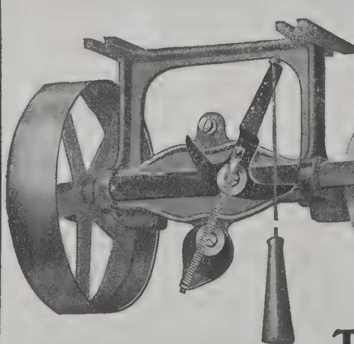

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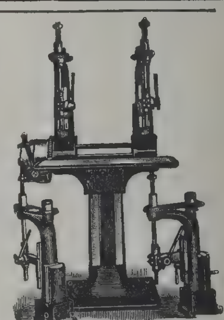

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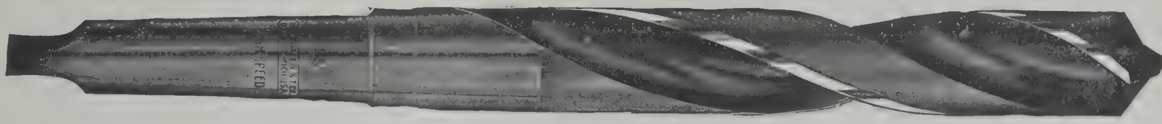

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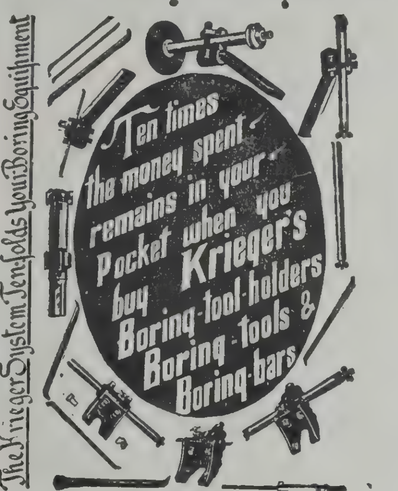

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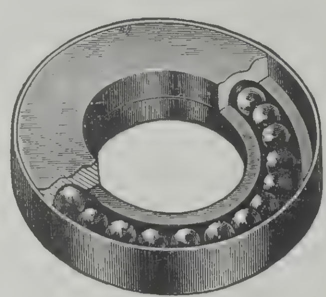

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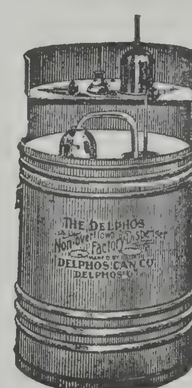

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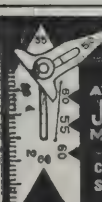

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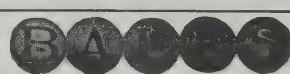

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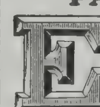

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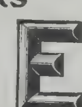

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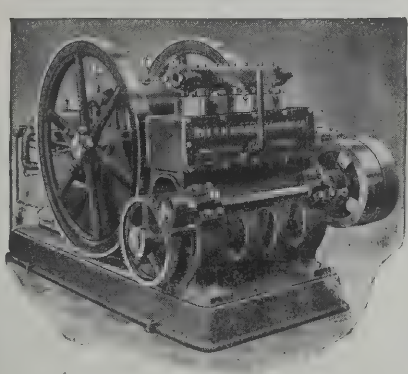

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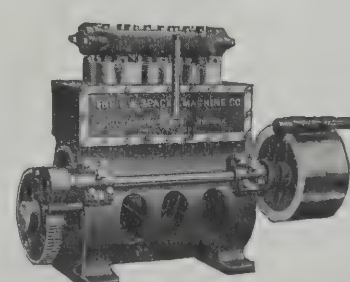

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10' Betts Vertical Boring Mill, two heads, practically new having been used only three months.
60" x 22' Open Side Detrick & Harvey Planer, three heads, in first class condition.
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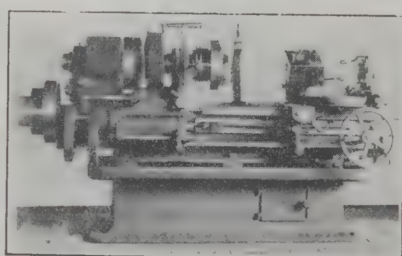

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New, "Near New" and 2nd-hand Machinery.

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Boring and Turning Mill. Bought new five years ago. Not used for last two years. Condition equal to new. Price, $4,500.

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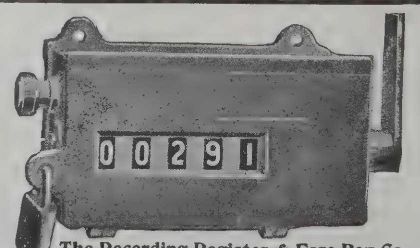

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All sizes Shapers—"G. & E."
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Immense Big Stock—some of the choice ones:
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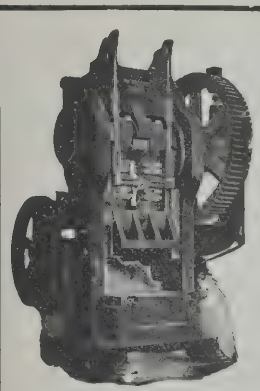

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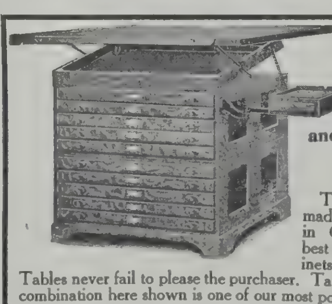

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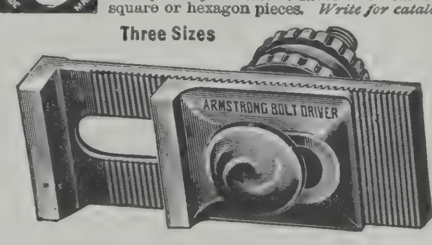

Armstrong Bros. Tool Co., "The Tool Holder People."
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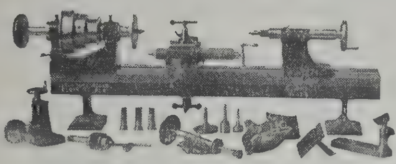
SEE OUR TOOL HOLDER AD. PAGE 116



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7 in. swing, 32 in. bed, 16 in. between centers.

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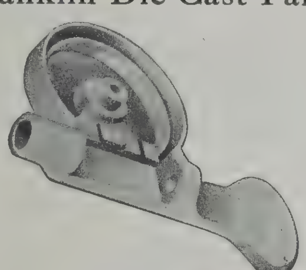

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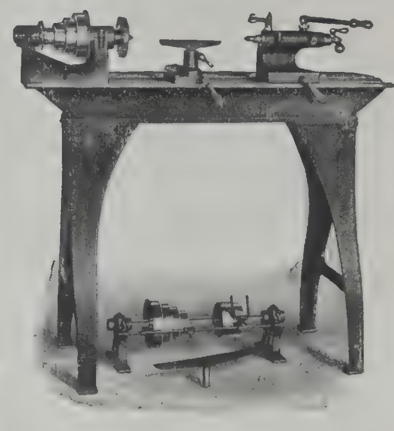
"Seneca Falls" Speed and Wood Turning LATHES



Are made by the same workmen and with the same care as are our celebrated "Star" Screw Cutting Engine Lathes.

These Lathes have reliable self-oiling, dust-proof bearings, hollow spindle of crucible steel. Tailstock with combination screw and lever feeds. Locking levers attached and always in place. Bed is unusually strong and rigid; thoroughly braced by cross webs. Countershaft has self-oiling and self-aligning shaft bearings. Can furnish with drawn-in chucks, and split collets for rod work, also oil pan, foot power, etc.

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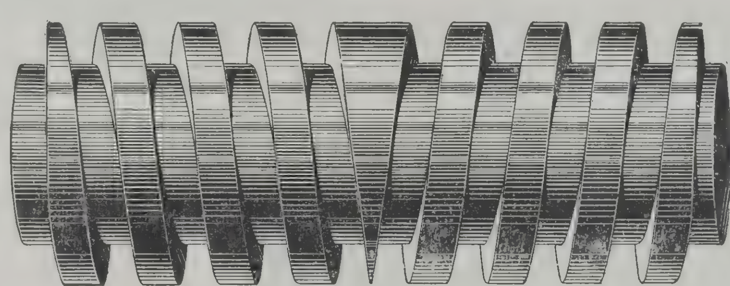
either internal or external, the Automatic Threading Lathe shows results in accuracy and finish which satisfy the most exacting workman. You can triple the output of the ordinary engine lathe with this machine and better the quality of work produced. Right or left hand threads, coarse or fine, it's all the same to the Automatic. Try it.



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AUTOMATIC MACHINE CO., BRIDGEPORT, CONNECTICUT

AGENTS—Alfred H. Schutte, Schuchardt & Schutte, C. W. Burton, Griffiths & Co., of London, England. Marshall & Huschart Machinery Co., of Chicago, Ill., and Motch & Merryweather Machinery Co., of Cleveland, O. Vandyck Churchill Co., Philadelphia, Pa.

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CHEAPER MOTIVE POWER?

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They're not the cheapest in first cost, but they're by far the cheapest in the long run.

If you are interested, drop us a line stating your requirements, and we'll send further information that will interest you.

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Let us Help you Solve your Gear Problems

We have been solving gear problems exclusively for several years, and it is only reasonable to suppose that our experience would prove of service to you. During these years we have helped the man whose problem was a low cost gear; the one whose problem was a smooth running gear and him whose problem was a gear of such design that it could not be cut with the milling cutter.

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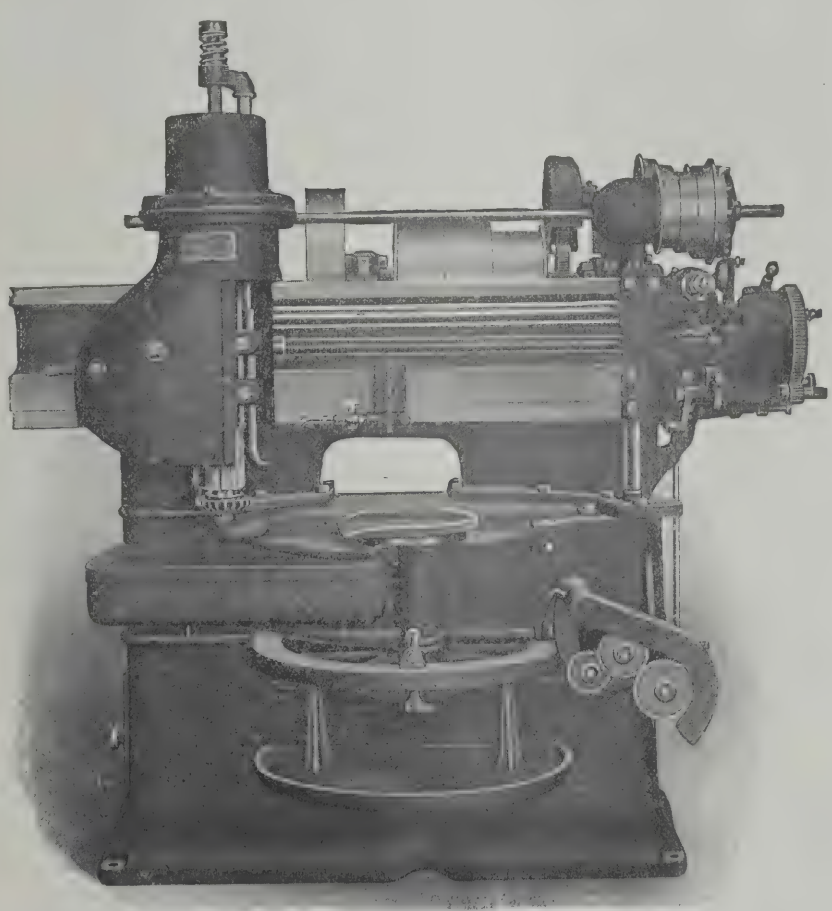
has become more vital in the past few years as competition has grown keener. Wherever we have installed Gear Shapers we have helped to solve this problem by reducing former cutting time 25 to 50%; this is a very conservative figure, and it is not in the least improbable that a Gear Shaper would actually reduce your cutting time much more than that. Anyhow, our guaranteed estimate would cost you nothing. Send us your prints, or better still, let our representative look over your work and give you detailed information.



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We have been equally successful in overcoming the difficulties of the man who was getting noisy gears. The ground generating cutter is largely responsible for this. It is simply impossible to cut an accurate gear with an unground cutter. Moral, use a cutter that is both theoretically correct and ground after it is hardened.

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Until the Gear Shaper came on the market, the designer was practically debarred from adopting many desirable forms. Among others the Gear Shaper has made practicable the step or cluster gear, as well as the internal. These were formerly made in pieces or not used at all, but cutting them from the solid, reduces the cost and improves the quality.

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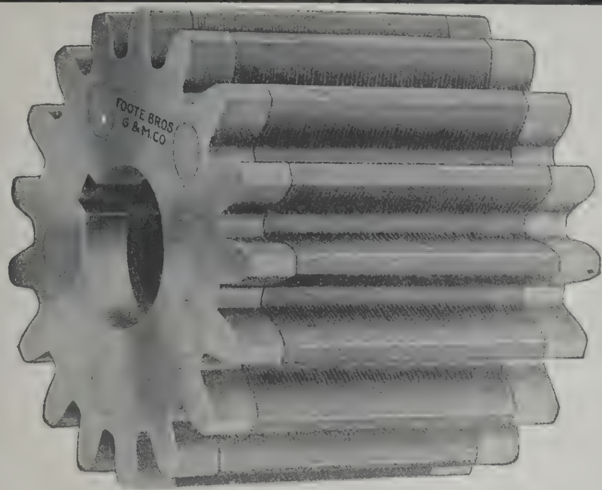

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your motion with our Rawhide Pinions. Foote Bros. Rawhide Gears and Pinions for reduction of speed are in a class by themselves—noisless, accurate, smooth running—the most successful on the market. Full line of Steel, Iron and Rawhide Gears made to order on short notice.

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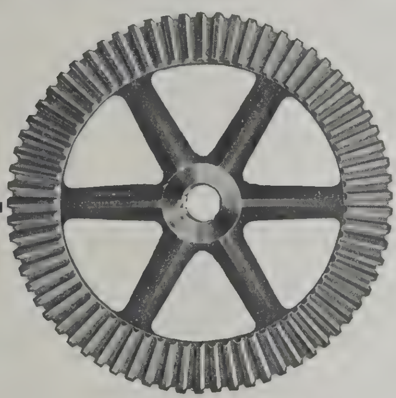

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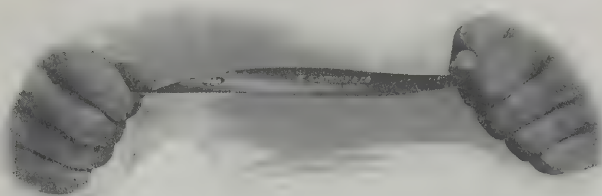

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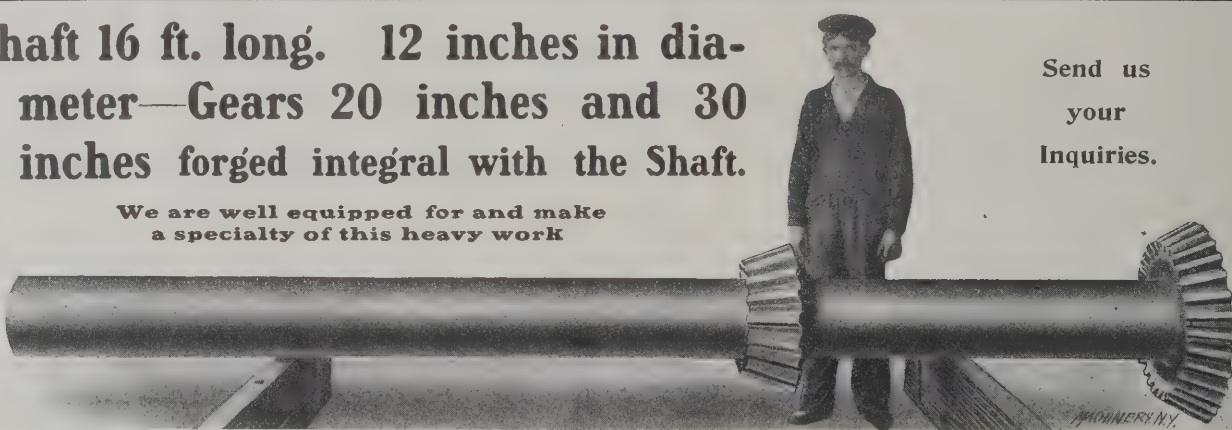

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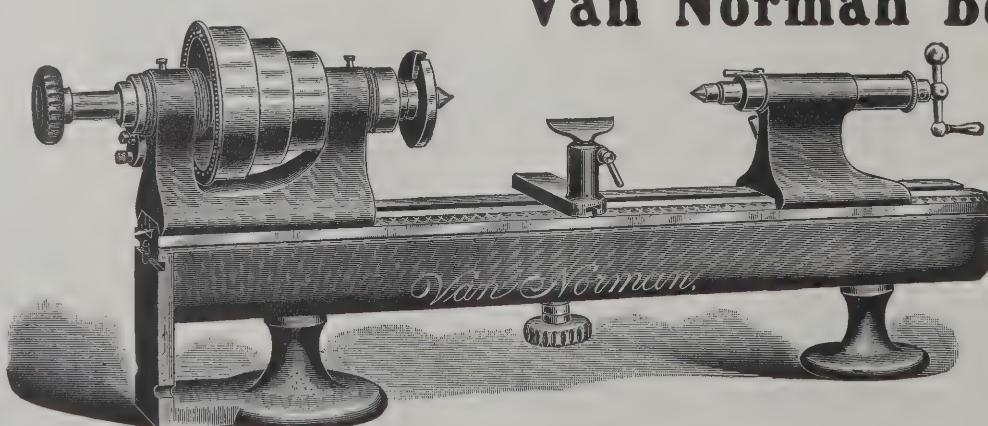

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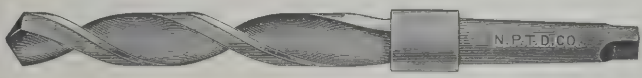

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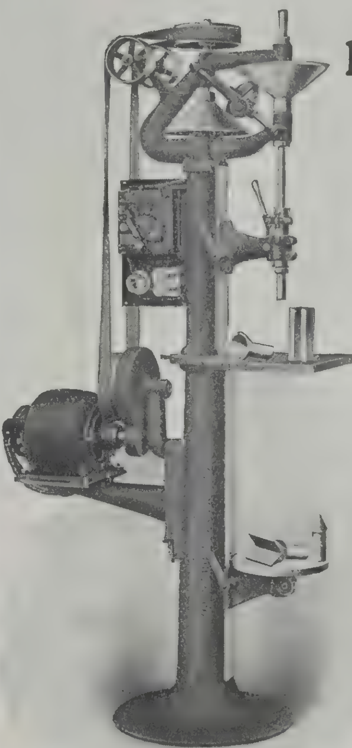

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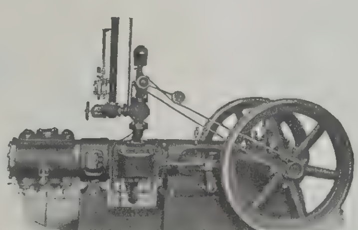

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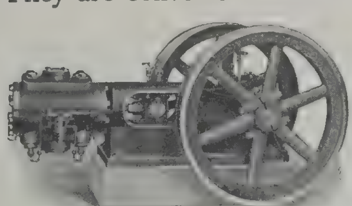

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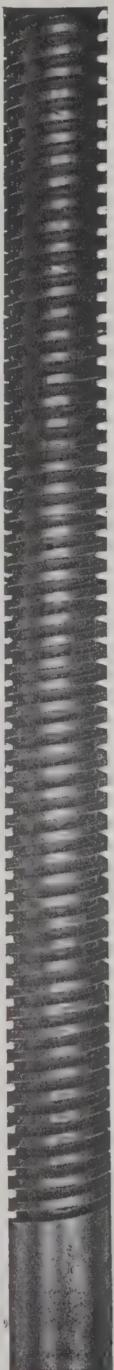


we are in a position to save considerable money for the manufacturer who uses screws in quantities

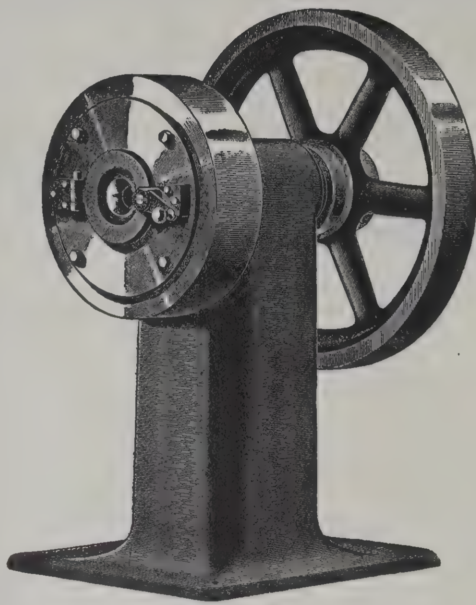
We make nothing but Screws, but there is no screw we cannot make, and make better and cheaper than any other concern, unless it had like facilities and concentrated its energies on this one line of product.

If you are making your own screws—write us before you turn another blank. Power, Lead, Feed Screws–any length, diameter, pitch or style of thread—screws for machine tools of every description and for every other purpose.

Full information on request.

The Screw Cutting Company of America

17th St. and Sedgley Ave.
Philadelphia, Pa.



No Waste or Weakening of Metal when reduced by Dayton Swaging Machines.

By striking 2000 to 6000 blows every minute these machines give an additional hardness, solidity and general toughness to the piece while the reduction is entirely by pressure and the work finished quickly and economically.

Send for a copy "The Modern Art of Swaging"—it's free.

THE EXCELSIOR NEEDLE CO., Torrington, Conn.

Coventry Swaging Co., Ltd., White Friars Lane, Coventry England, Agents for Great Britain, Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France, Agents for France, Italy, Spain, Portugal and Switzerland.

"Capital" **"ULTRA CAPITAL"** "Capital"

New Water Hardening High Speed Steel.

Keen edge, lasts 5 to 8 times ordinary high speed.

DRAWN FLATS, key steel or tool steel from stock. Shapes of any kind to order. Largest assortment of bright material—strips, sheets, bars and wire.

Edgar T. Ward & Sons, **23-25 Purchase St., Boston, Mass.**

A 288 Page Catalog for the asking

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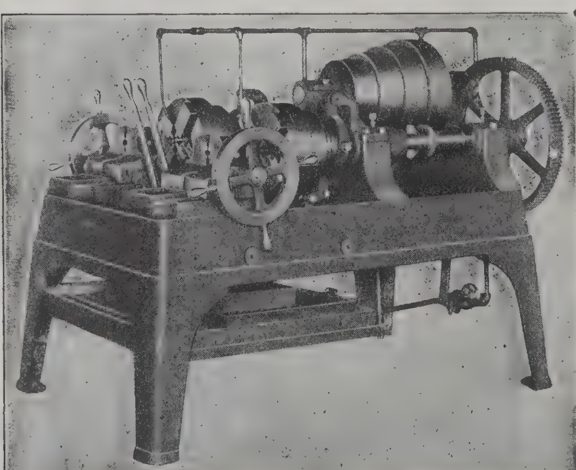
MONTGOMERY & CO.
105-107 Fulton Street, New York City



One Murchey Threading Machine Cuts More Threads in a Given Time than Three Machines of Other Makes

The Murchey Double Head Nipple and Pipe Threading Machine threads pipe in lengths from a close nipple to a full length of pipe, stands hard and continuous service, reams and threads at one operation, has six changes of speed, ample power and requires no attention after starting the pipe in the die head.

Made in various sizes, belt or motor drive. Write for catalog.

MURCHEY MACHINE & TOOL COMPANY
4th and Porter Sts. **DETROIT, MICH., U. S. A.**

Trade Mark *Registered*

This Advertisement Appears but Once

Don't Miss Your Chance

To the purchasing agent of every newspaper and magazine, every printer, machinist, stationary and marine engineer, machine shop foreman and to the "Boss" himself, we wish to send **absolutely free** a copy of our

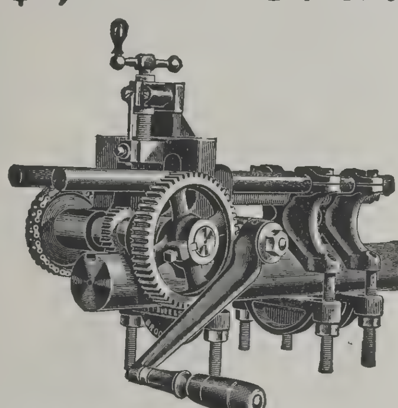
BOOKLET

containing components of various grades of Babbitt Metal, white brass components for die casting process, components for electrotyper, newspapers and printers who run such machines as the autoplate, linotype, compositype, and monotype.

This valuable booklet compiled and published by I. Shonberg is the result of thirty years' experience as a metalman and metalmixer. Send for your copy today, it costs nothing—not even postage. All we ask in return is a simple acknowledgement of its receipt, and that you will read it and read it carefully.

I. SHONBERG, 363 Hudson Avenue, Brooklyn, N. Y.

$40. F. O. B. New York.



This No. 1 Portable Shaft Keyseater

is indispensable to the repair shop. It will mill keyseats in the middle or on the ends of shafting from 1¼″ to 5″ in diameter without removing from the hangers. It can be slipped over heavy shafting or spindles when desired; can be operated in the most awkward places, and will mill a keyseat 12″ long without resetting.

Other advantages are its rapid operation, accuracy of work produced and the fact that it cuts without jar or chatter of any kind.

We shall be glad to send full details on request.

JOHN T. BURR & SONS, 429 Kent Ave., Brooklyn, N. Y.

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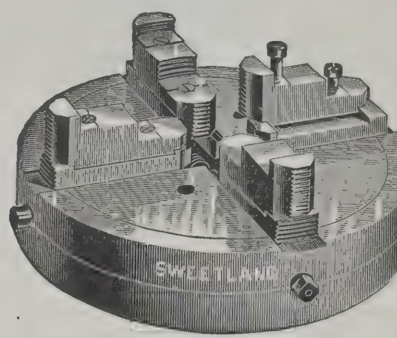
BABBITT METALS

FOR EVERY REQUIREMENT

LUMEN BEARING CO., BUFFALO

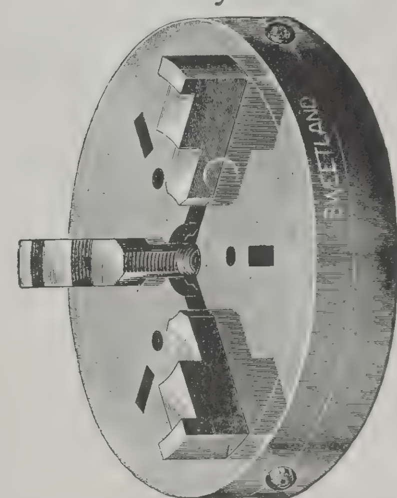
CHUCK JAWS

that are ground perfectly true.



SWEETLAND LATHE CHUCKS

are best because of their gripping power and durability.



HOGGSON & PETTIS CO.
NEW HAVEN, CONN., U. S. A.
103 Chambers St., New York.

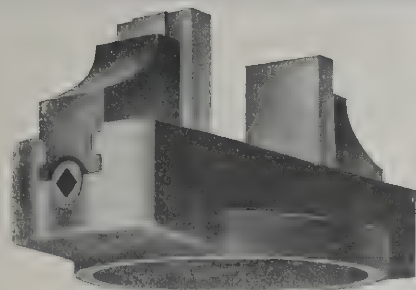
DRILL CHUCKS.

For sale by De Fries & Co., Dusseldorf, Germany.
Charles Churchill & Co., Ltd. London, Eng.

Trump Bros. Machine Company,
MANUFACTURERS
Wilmington, Del., U. S. A.

HOISTS,

New Patent Whip
Patent Friction Pulleys,
NONE BETTER
MANUFACTURED BY
VOLNEY W. MASON & CO., PROVIDENCE, R. I., U. S. A.



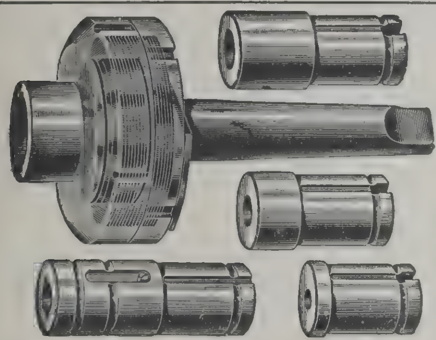
A Box Body Chuck

with Face Plate Recess. Can be easily mounted on any machine. Has socket Screw, Slip Jaws made of Cast Iron or Machinery Steel.

The regular Chuck is Universal, but we furnish with Independent Jaws also.

MAKERS OF A COMPLETE LINE OF CHUCKS

UNION MFG. CO., New Britain, Conn., U.S.A.
26 Cortlandt St., New York.



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Safety Drill & Tap Holder

is the only attachment for the purpose that gives universal satisfaction, and is

UNEQUALLED in Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to Break or get out of Order. Made in 4 sizes, covering from 0 to 2½ in. diameter.

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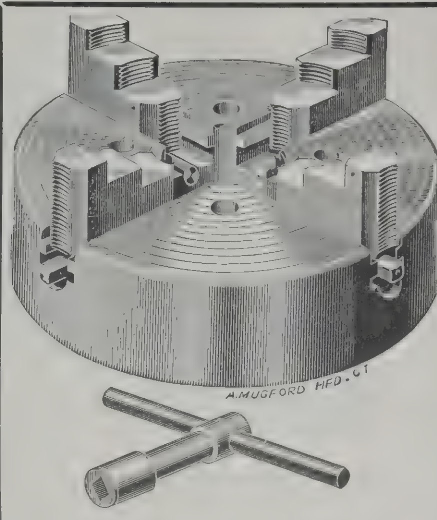


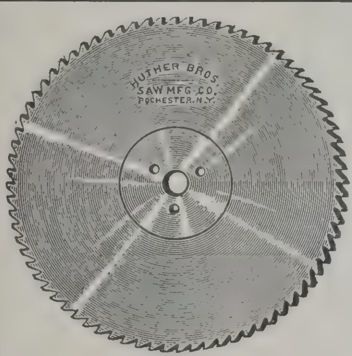
Horton Chucks

have been weighed in the balance, and not found wanting.

QUALITY

has upheld them for more than **50 years.** Experience and an intimate knowledge of what is required of Modern Machine Tools, enable us to furnish exactly the **Chuck** that is needed. Buy the best: The "Just as Good" brand rarely gives satisfaction.

The E. Horton & Son Co.
Windsor Locks, Conn., U.S.A.



MILLING SAWS

And Cutters

Saws made from High Speed and Carbon Steels.

LET US SEND YOU ONE TO COMPARE RESULTS OBTAINED.

Huther Bros. Saw Mfg. Co.
ROCHESTER, N. Y., U. S. A.
We also Manufacture Sheet Steel Specialties.

THE CINCINNATI CHUCK CO.

A Strong Point in Cincinnati Independent Chucks

is mounting the screws in hardened steel bushings. This method is peculiar to the Cincinnati Chuck, gives three times the wearing qualities of other chucks, and screws are held in perfect line with the jaws. Another advantage—should end play develop, it can be easily taken up by any machinist.

The circular is worth writing for.

THE CINCINNATI CHUCK CO.
Cincinnati, Ohio
New York Office: 136 Liberty St.
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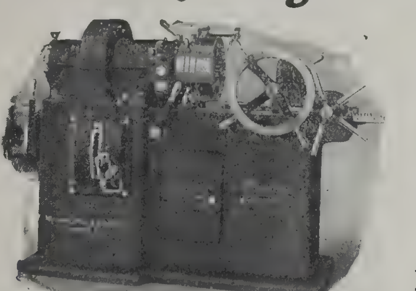
Plurality High Power Bolt Cutters



Quick change, instant adjustment, durability and low cost of maintenance of dies are strong reasons in favor of a "Plurality" Installation.

High Power Machines, with constant gear drives and a superior lubricating system, they cost less, work faster and last longer than most other makes.

Write for Circular

Mummert, Wolf & Dixon Co.
HANOVER, PA.

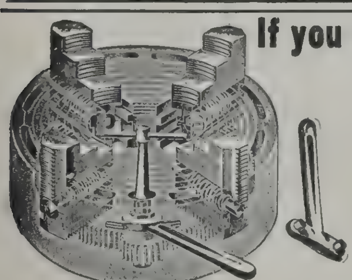
SHAPERS

14-inch to 32-inch Stroke.

Crank and Triple Geared.

John Steptoe Shaper Company, Cincinnati, Ohio.

If you want the best Lathe or Drill Chucks—buy Westcott's



Spur Geared Scroll Combination Lathe Chuck.

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

Strongest Grip, Greatest Capacity. Great Durability, Accurate.

WESTCOTT CHUCK CO., Oneida, N. Y., U. S. A.

Ask for catalogue in English, French, Spanish or German.

Little Giant Auxiliary Screw Drill Chuck.

Are you Seeking an Intelligent Drill Chuck?

IF SO, YOU'LL FIND THE

New Almond Geared Chuck

A WORTHY ACQUAINTANCE

THE NEW
ALMOND
GEARED CHUCK

OUR STORY

Direct Power
Bushed Pinion Holes
Interchangeable Pinions
Gear Teeth on Split-Ring
Increased Tightening Power

OUR CLAIMS

The New Almond Geared Chuck represents the highest improved principle of thirty years education in building drill chucks.

LET IT BE UNDERSTOOD

The New Almond Geared Chuck is the result of honest, care-taking endeavor in manufacture. Our assurance is your guarantee.

Having every improvement worthy of the name, the Almond Geared Chuck assures the user convenience, quality and endurance.

Because of its practical advantages—found in no other drill chuck—the New Almond Geared Chuck has a distinct individuality. Its users are intelligent discriminators.

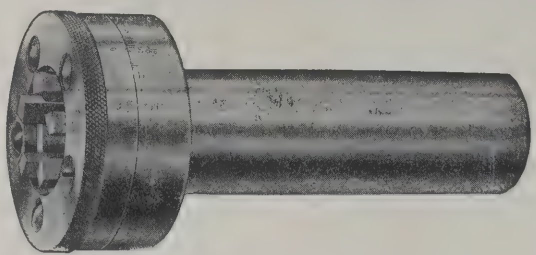
We've moved to the high pinnacle in the chuck-building world and are proud of our new drill chuck. Investigation of its merits will justify our conceit.

For folder concerning drill chucks that are right, address,

T. R. Almond Manufacturing Company

2 MAPLE AVE., ASHBURNHAM, MASS., U. S. A.

One Reason for the Popularity of the Adjustable Hollow Milling Tool is that no other device can so rapidly produce Accurate, Uniform Diameters.


Adjustable Hollow Milling Tool

It is a tool designed for use on screw machines, hand turret lathes, or it may be rotated in any way required. It can be quickly set to any diameter within its capacity by means of the index, and as quickly changed from one diameter to another; will reduce work of any length and will mill close to a shoulder.

Simple in construction, strong, calculated to stand rough usage and made in various sizes.

Write for Catalogue of time saving tools.

The Geometric Tool Co., Westville Station, New Haven, Conn., U. S. A.

Pacific Coast Agents—The Compressed Air Machinery Co., San Francisco, Cal.
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SAVE THE DRILLS

the operator's time and insure accurate work by using

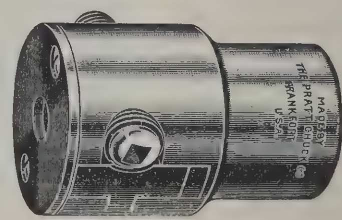
Russell Anti-Friction Drill Chucks

The "Russell" is self-tightening, automatic, will not slip under any stress—requires no key, wrench or spanner for adjustment, and incidentally is the only successful drill chuck for automatic machines. Jaws are interchangeable also. Catalogue?

RUSSELL ANTI-FRICTION DRILL CHUCK CO.
ELMIRA, N. Y., U. S. A.

Distributing Agents for Canada: The General Supply Company of Canada, Ltd., Ottawa.

Tool can't slip or work loose with a Pratt Chuck



It holds the drill or other tool with absolute firmness and without scarring the shank. A time saver, too, with the tool secure the operator can give all his attention to speed and accuracy of his work. Simple in construction, strong, long wearing and especially adapted for high speed drilling.

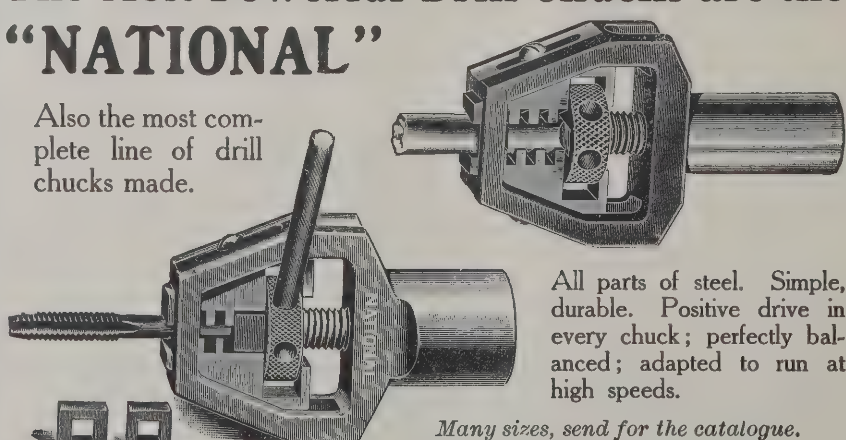
Catalogue on request.

THE PRATT CHUCK CO.
Frankfort, N. Y.

European Agents: Selig Sonnenthal & Co., 85 Queen Victoria Street, London, England.

The Most Powerful Drill Chucks are the "NATIONAL"

Also the most complete line of drill chucks made.



All parts of steel. Simple, durable. Positive drive in every chuck; perfectly balanced; adapted to run at high speeds.

Many sizes, send for the catalogue.

Oneida National Chuck Co., Oneida, N. Y.

FORGINGS

For Machinery Builders

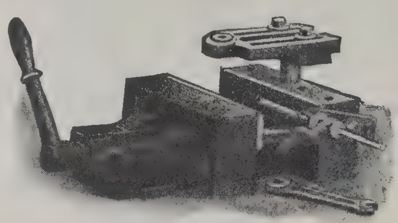
We have Steam Hammers, Drop Hammers, Trip Hammers and Upsetters.

The Machinery Forging Co.
CLEVELAND, O.

DRILL VISE

A plain vise and at the same time does duplicate drilling without the cost of a jig.

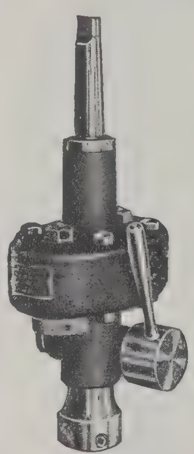
Patented.



DRILL SPEEDER

For use in all presses from 20" up

Patented.



NOTE

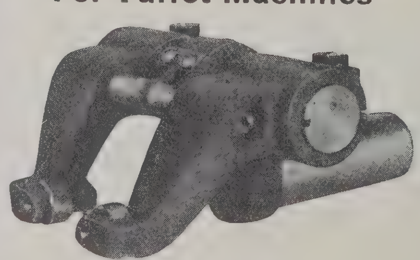
1—It increases the speed three times.

2—It has safety frictions to save the drills.

3—It has sensitive feed lever.

KNURL HOLDER

For Turret Machines



Patented Aug. 10, 1909.

SOME THINGS ABOUT IT

1—It fits into any turret head.

2—It will knurl any size within its capacity, viz: 2½ diam. x 2½ long.

3—It is run onto the work like a screw plate.

Send for Circulars.

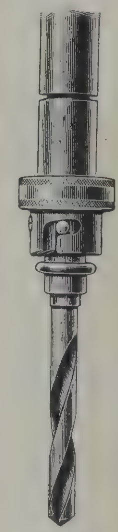
The Graham Mfg. Co.

Providence, R. I.

DO YOU EVER CHANGE TOOLS?

If so, let us send you

THE FAMOUS WIZARD CHUCK



on trial and prove to you that it is the best quick-change chuck ever devised. This has been proven in many of the best and biggest shops in the country. You can use practically all sizes and kinds of tools in rapid succession

WITHOUT STOPPING THE MACHINE.

The **only** chuck and collets that holds the tool **rigid and perfectly centered.** Note taper on upper end of Wizard collets.

Wizard collets are regularly furnished for Morse taper shank tools, straight shanks, or taps. Collet blanks may also easily be bored for any kind of special shank.

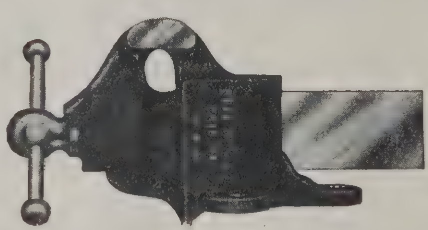
An immense time-saver and cost reducer. Let us send you detailed information.

THE McCROSKY REAMER COMPANY, Inc.

Successors to F. B. McCrosky Mfg. Co

MEADVILLE, PA.

THE REED GUARANTEE



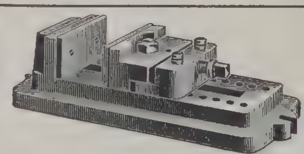
is for LIFE. Any

REED VISE

which does not give absolute satisfaction will be replaced, or your money refunded. Can you think of a fairer proposition?

Catalogue H for the asking.

REED MANUFACTURING CO., Erie, Pa., U. S. A.

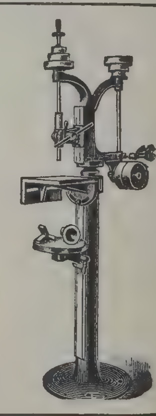


SAVE TIME

in your upright drill work by using the Hopkinson Drill Vise. It's just as necessary for drilling as a chuck is for lathe work. It's universally approved by up-to-date mechanics.

HOPKINSON MACHINE WORKS CO., SPRINGFIELD, MASS., U.S.A.

MY PRODUCT CONSISTS OF



SENSITIVE DRILLS 1 to 12 spindles. With or without power feed.

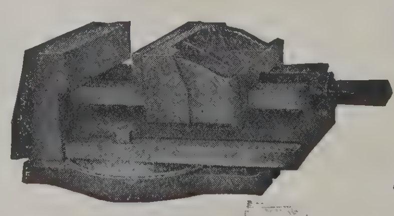
CLAMP DRILLS 2 styles. 4 sizes.

BLACKSMITH DRILLS Hand and Power.

NUT TAPPERS 2, 3, 4 spindles.

PLANER CHUCKS Round and square base. 6, 8, 10, 12, 15, 18, 24 and 30" jaws.

FRANCIS REED CO. - Worcester, Mass.



Plunket Improved Vises

Made with Plain or Swivel Base

Specially adapted for the hard service of the machine shop. Can be used with every style drill-press, shaper and milling machine. Strongest construction, steel screw, steel faces to jaw, cast steel handle. Write for further information.

J. E. PLUNKET, Chicago, Ill.

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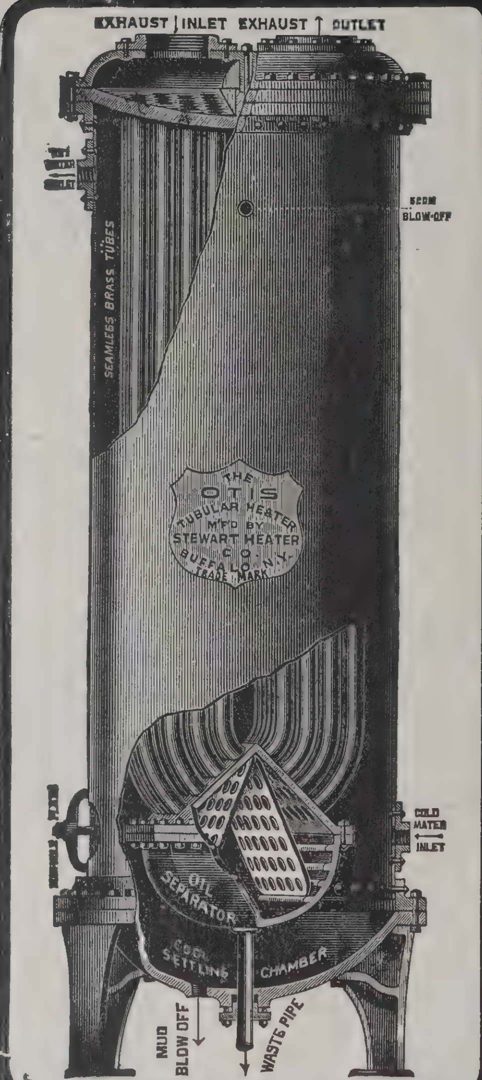


THE OTIS

Tubular Feed Water Heater, Oil Separator and Purifier

is not an experiment but a tried and trusted appliance that the makers are not afraid to

GUARANTEE

To heat the feed water to the *boiling point* (210 to 212 degrees) with the exhaust steam without causing any back pressure, *also to extract the oil from the exhaust*, so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the *additional expense* of an *eliminator*.

We are so sure of the OTIS that we agree to pay all cost of a trial—freight, cartage, piping, etc.—if it fails to do all we claim for it.

Catalogue and Prices at your Service

The Stewart Heater Company

79-99 East Delevan Ave., BUFFALO, N. Y.

POOLE ENGINEERING & MACHINE CO.
ENGINEERS, FOUNDERS AND MACHINISTS.
BALTIMORE, MD.
MANUFACTURERS AND DESIGNERS OF ALL KINDS OF
HEAVY MACHINERY,
FIRST CLASS WORKMASHIP AND MATERIALS.
ROPE WHEELS, FRICTION CLUTCHES, SHAFTING, PULLEYS AND HANGERS.
MACHINE MOLDED AND PLANED GEARING.
MACHINERY FOR WHITE LEAD, FERTILIZER WORKS, GRAIN ELEVATORS, FLOUR MILLS, BRASS, COPPER, TIN PLATE ROLLING MILLS, CABLE, MARINE RAILWAYS.
POOLE-LEFFEL TURBINE WATER WHEELS
DREDGING MACHINES
CIRCULARS ON APPLICATION.
CASTINGS 30,000 LBS. TENSILE STRENGTH

A SHULTZ SABLE BELT DOESN'T RIDE ON THE HIGH SPOTS

Take a look at any oak-tanned belt running over a small pulley. The belt is probably so stiff that it only has a 120° contact when it should have 180°.

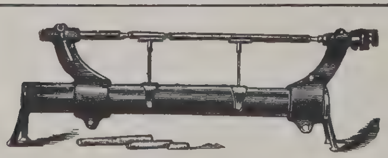
A **Shultz Sable Rawhide Belt** is different. It is so soft and pliable that it just hugs the pulley and on account of its kidlike surface transmits one-third more power than any oak-tanned belt for the same arc of contact, and without the aid of belt dressing.

Write for our booklet No. 32.

SHULTZ BELTING CO., St. Louis, Mo.

New York Boston Philadelphia

53 B



(Style of 12 and 24 Sizes.)

Measuring Machines.

Measuring screw, 10, 16 or 20 threads to the inch, graduated to read thousandths or 32ds without calculation.

The only Micrometer that will not lose its accuracy by wear.

SYRACUSE TWIST DRILL CO., SYRACUSE, N. Y.

Chas. Churchill & Co., Ltd., London, Eng., Agents for Great Britain

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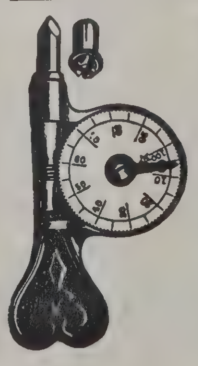


WOODMAN & HUDSON'S Speed Indicator.

An ingenious little instrument for ascertaining the correct speed of Dynamos, Steam Engines, Shafting, Floor Machines, etc. No first class mechanic, superintendent or factory should be without one. They are adapted to hollow or pointed centers, and are absolutely correct. Every indicator is handsomely nickel-plated and of convenient size to carry in the pocket.

Price: Split Cap, adapted to either pointed or hollow centers, $1.00.
Plain Cap, for hollow centers only, 75c.

We also keep a Double Registering Speed Indicator. Prices on application.

The R. Woodman Mfg. and Supply Co., 63 Oliver Street, BOSTON, MASS.

The Beaudry Champion Power Hammer

Simple Durable Efficient Economical

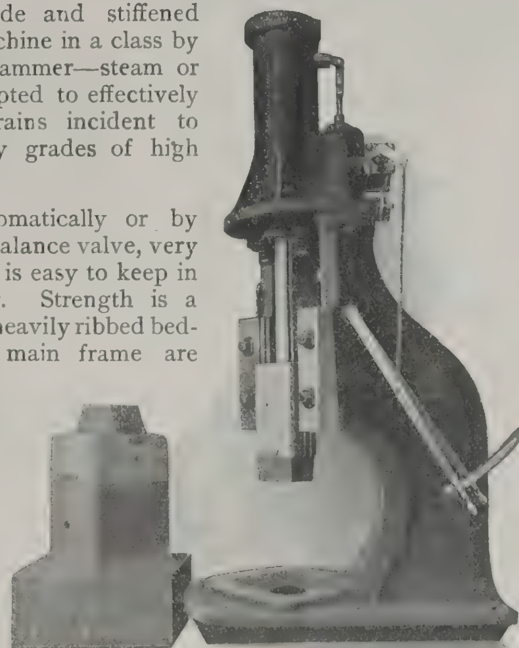
Adapted for every description of forging.

Send for circular.

BEAUDRY & CO., Inc.
141 Milk Street, BOSTON, MASS.

The Construction of the Single Frame Guide Type Bell Hammer

with reinforced guide and stiffened column puts this machine in a class by itself as the only Hammer—steam or compressed air—adapted to effectively resist the great strains incident to working present day grades of high carbon steel.

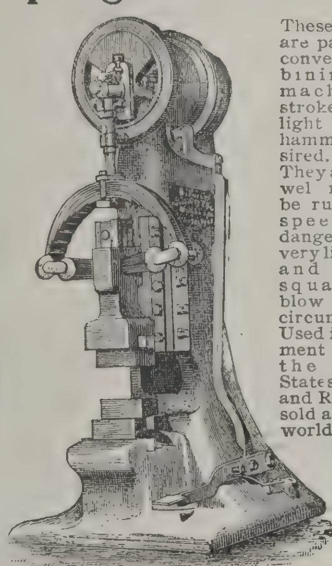


It is operated automatically or by hand, has improved balance valve, very sensitive control and is easy to keep in good running order. Strength is a special feature. The heavily ribbed bed-plate and massive main frame are made in one piece; the anvils are heavy, dies of liberal depth and hammer head and piston rod made of forged steel.

We shall be glad to send special circular with full description. Our line includes all types and sizes of Steam Hammers.

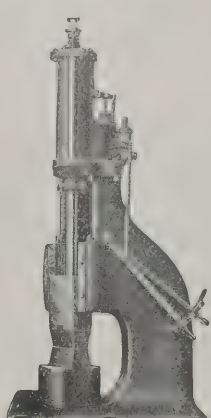
Buffalo Foundry and Machine Company
53 Winchester Avenue, BUFFALO, NEW YORK

Spring Power Hammers



These hammers are particularly convenient combining in one machine the stroke of a very light or heavy hammer as desired.
They are strong, wel made, can be run at high speed without danger, require very little power and strike a square, true blow under all circumstances.
Used in government shops by the United States, France and Russia, and sold all over the world.

Dienelt & Eisenhardt, Inc.
1304 No. Howard Street
PHILADELPHIA, PA., U. S. A.

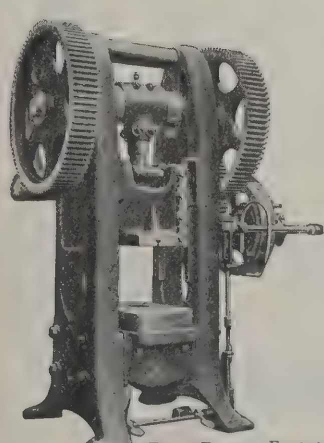


Single Frame Hammer

ERIE HAMMERS

Single Frame, 250 lbs. to 3,000 lbs.
Double Frame, 600 lbs. to 10,000 lbs.
Steam Drop Hammers, 400 lbs. to 7,000 lbs.
Plate Shears

ERIE FOUNDRY COMPANY
Erie, Pa., U. S. A.



Press D 121

Press D 121 is of recent design and embodies the latest improvements in heavy single-action presses. It exerts a pressure of 200 tons and is adapted for drawing cold from heavy sheet steel, deep seamless shells, automobile hubs, ball-bearing cups, etc. The castings are heavy and the wide-faced twin gears equalize the pressure. Friction clutch.

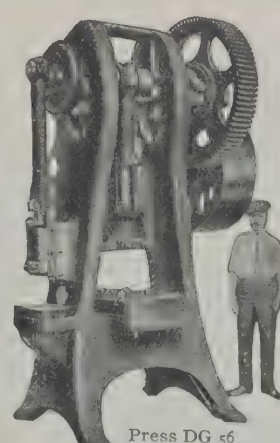
FERRACUTE PRESSES

HUNDREDS OF SIZES AND STYLES

FOR CUTTING, FORMING, PUNCHING, DRAWING AND EMBOSSING BAR AND SHEET METALS, PAPER, LEATHER ETC.
FERRACUTE MACHINE CO., BRIDGETON, N. JERSEY, U.S.A.

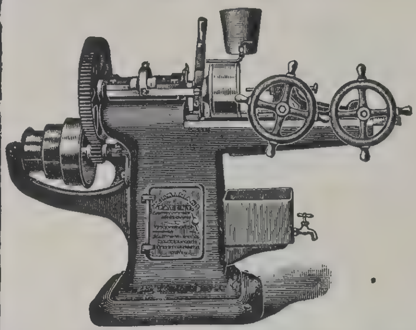
Press DG 56 with the Side Punch is a single-action, straight-column, geared press with rigid frame and long stroke, particularly adapted for deepening shells, but also useful for any single-action work requiring a long stroke. Pressure exerted, 100 tons. The Side Punch is convenient for light punching, shearing and trimming. Send for photographs and full information.

European Agents: Chas. Churchill & Co., London; Fenwick Freres & Co. Paris; Wilh. Sonneson & Co., Copenhagen



Press DG 56 with Side Punch

A BOLT CUTTER IS MUCH LIKE A MAN IN THIS:



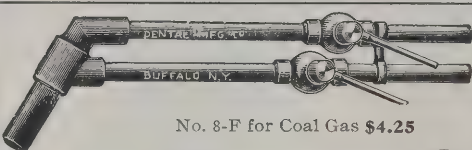
The Head Is Nearly Everything

The Merriman Bolt Cutter Head is Noted for

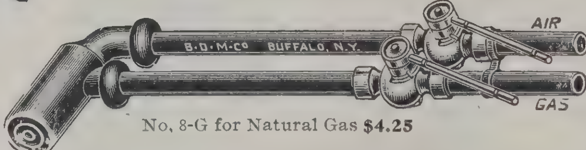
1. Simplicity of the head; Only four parts, consequently,
2. Great Durability. Few repairs needed.
3. Square Bearing of the Dies in the Ring; consequently,
4. Solidity of the Dies like a Solid Die; Consequently,
5. Uniformity of the product; Bolts all the same size.
6. Effectiveness of Operation; Cheapest help can understand and run it.
7. No machine turns out work more rapidly.

THE H. B. BROWN CO., EAST HAMPTON, CONN.

Send for Catalog No. 12.



No. 8-F for Coal Gas **$4.25**



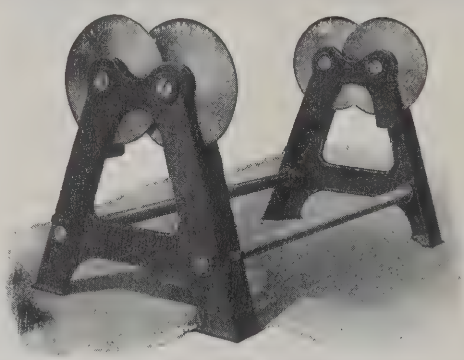
No. 8-G for Natural Gas **$4.25**

Brazing Blowpipes THAT BRAZE

In proof of this assertion we recently witnessed the brazing together of two sections of 6″ square cast iron traveling beam from a wire machine, using three of our No. 8-G natural gas blowpipes, with perfect results. This shows an extreme brazing operation, and proves "B. D. M. CO." blowpipes are equal to the emergency. We make blowpipes for use with all kinds of gases and can meet your requirements. Write us about your brazing troubles, and we will advise you the proper size blowpipes to use and give you the benefit of our forty years experience in brazing matters.

Catalog "B. M." is yours for the asking. Illustrates everything of interest to the machine shop.

BUFFALO DENTAL MFG. CO., Buffalo, N. Y., U. S. A.



Twentieth Century Balancing Tool

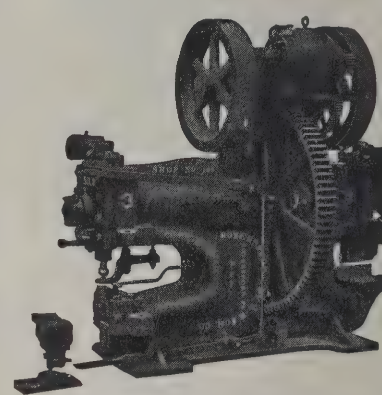
Always Level—No matter where or how you place it. Always ready.

A practical tool for balancing pulleys, cones, polishing wheels, etc., requires no leveling or adjusting. Two sizes—No 1, for bench use, will balance 22″ pulley. Greatest distance between standards 20″. Net Price $15.00.

No. 2—For floor use—balances work up to 46″ diameter. Greatest distance between standards 30″. Net Price $18.00.

Manufactured by

Rockford Tool Company
Rockford, Ill.



ROYERSFORD PUNCH AND SHEARS

None better—few as good. Just the machine for Boiler Shops, Railroad Shops, Structural Works and Machine Shops. Machine is right; so is price.

New Catalog just out. Ask for one.

Royersford Foundry & Machine Co., Inc.
ROYERSFORD, PA.

BRASS CASTINGS

ANY SIZE FOR ANY PURPOSE

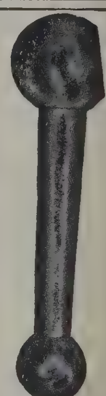
LUMEN BEARING CO., BUFFALO

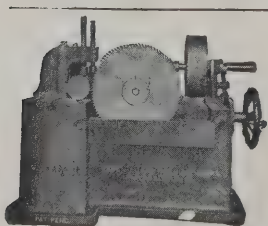
COMPARE

with your present Handle costs, our prices for Ball Cranks and Machine Handles of every description, from bar steel. Accurate, highly finished, complete in every detail and ready to attach.

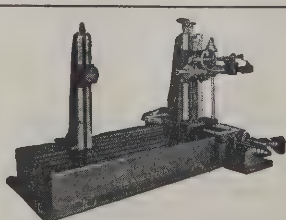
The Cincinnati Ball Crank Co.
Cincinnati, Ohio

Successors to this dept. of the SCHACHT MFG. CO.

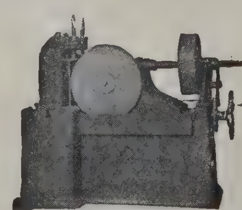




No. 7 Bar Cold Saw



No. 2 Horizontal Floor Boring Milling and Drilling Machine.



PATENTS PENDING
No. 2 I-Beam Cold Saw

WRITE FOR CATALOG

ESPEN-LUCAS MACHINE WORKS

Broad and Noble Sts., PHILADELPHIA, PA.

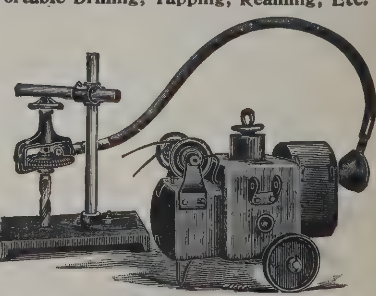
"CINCINNATI" PUNCHES

THE CINCINNATI PUNCH & SHEAR CO., Cincinnati, Ohio

Combination of

Stow Flexible Shaft and Multi-Speed Electric Motor

Portable Drilling, Tapping, Reaming, Etc.



Stow Mfg. Company
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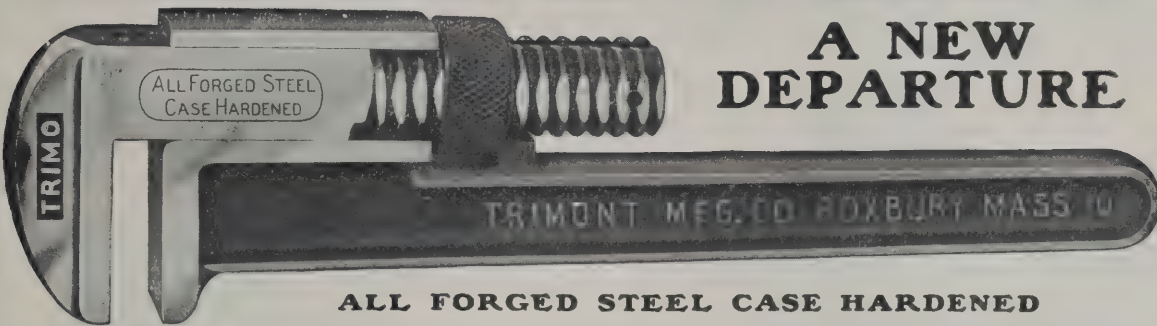
TRIMO MONKEY WRENCH



A NEW DEPARTURE

If you have not seen the U. S. Government tests on this tool, write us and we will mail you our booklet

"Facts Are Stubborn Things"

Postage Prepaid

Send for Catalog No. 38.

ALL FORGED STEEL CASE HARDENED

The movable jaw extends outward instead of toward the handle, therefore the larger the nut the longer the leverage

Made by TRIMONT MANUFACTURING CO., 55 to 71 Amory St., Roxbury, Mass., U. S. A.

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BUILT FOR ACCURATE WORK. BUILT FOR HARD WORK.

Engineers and Steam Fitters demand the best.

For sale by ALL LEADING JOBBERS in the country.

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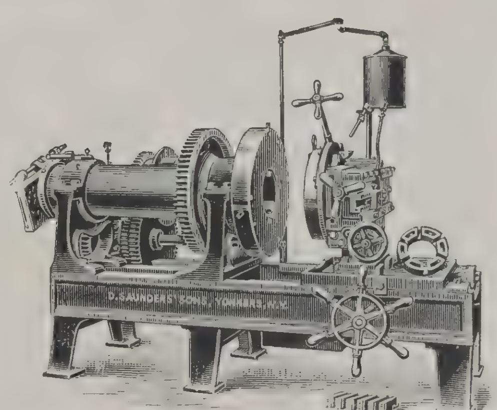
The Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn.

All genuine Armstrong Tools bear this trademark. Look for it and insist upon having it.

You know what you want—see that you get what you ask for.

Saunders' Pipe Threading and Cutting Machines

are built on the right principle—there is ample metal correctly distributed, large wearing and bearing surfaces, capacity is great and the freedom from breakdowns unparalleled. The No. 6 Improved Standard Machine has all these advantages, capacity for cutting off and threading pipe from 2½ to 8", and range of speeds suited to the work required. A special arrangement of gearing avoids the use of large pulleys and tight belts. The cutting head is so placed on the carriage that the die-head can be brought close to the gripping chuck, thereby permitting short pieces of pipe to be threaded without the use of a nipple chuck.



Full line of sizes—send for the catalogue.

D. SAUNDERS' SONS, Yonkers, New York, U.S.A.

Pipe Threaders and Cutters

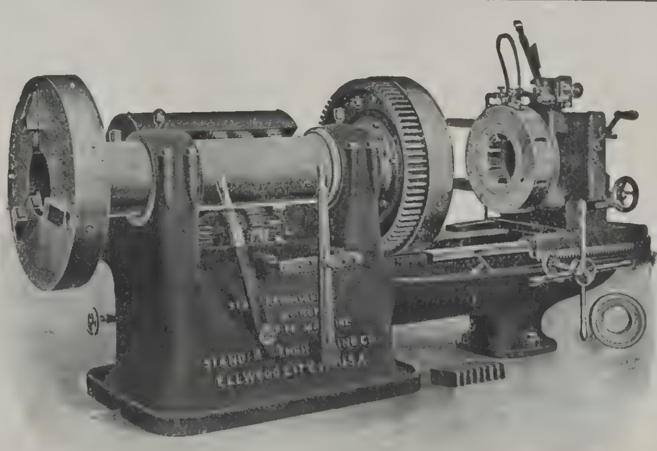
With efficiency as well as beauty.

Heavy—none more so; bed cast in one piece, no stands or legs to work loose. No oil soaked floors; fire risk reduced.

Single speed pulley; all gear speed changes through semi-steel cut gears.

Deep chasers cutting long taper perfect threads in one cut as easily on steel as on iron pipes.

Let us prove to you that the higher cost of a modern tool is justified by the character and quantity of its product. Circulars for the asking



Standard Engineering Co.,

Ellwood City, Penna.

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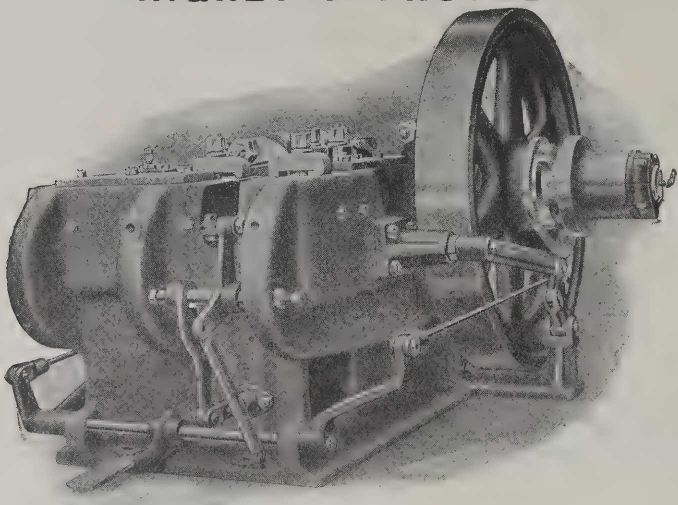

Moline Upsetting and Forging Machine

THIS MACHINE HAS SOME VALUABLE IMPROVEMENTS OVER OTHER MAKES. WE INVITE INQUIRIES.

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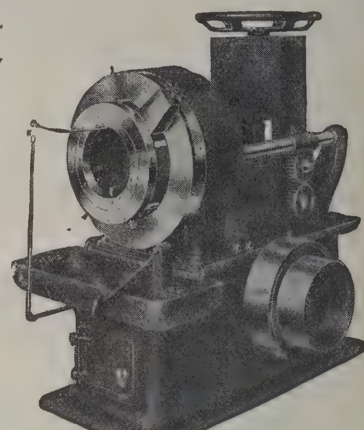
The Up-to-date Manufacturer Wants the Best

The **BEST** is that which will produce the greatest amount of work for the money expended.

In Pipe Threading Machinery it's

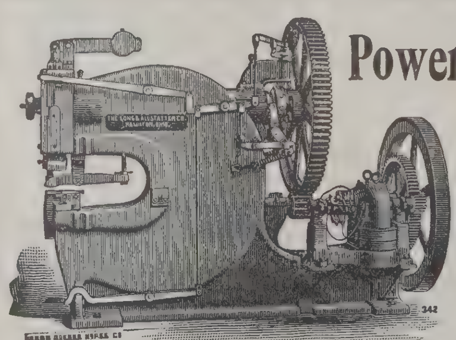
The Loew Victor



all sizes and types to suit all conditions. Let us tell you why the Loew Victor is more economical than any other; and why it has become the most popular pipe machine on the market.

The Loew Manufacturing Company

Cleveland, Ohio, U. S. A.



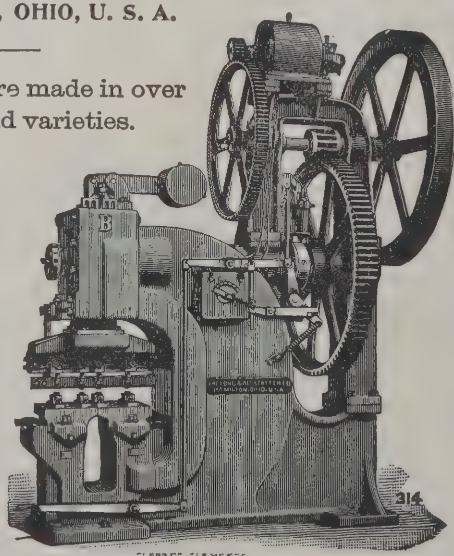
Power Punching and Shearing Machines

Belt, Steam and Electrically driven.

LONG & ALLSTATTER CO.

HAMILTON, OHIO, U. S. A.

Our machines are made in over 350 sizes and varieties.



SINGLE,
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Railroad Shops,
Locomotive Shops,
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Etc.

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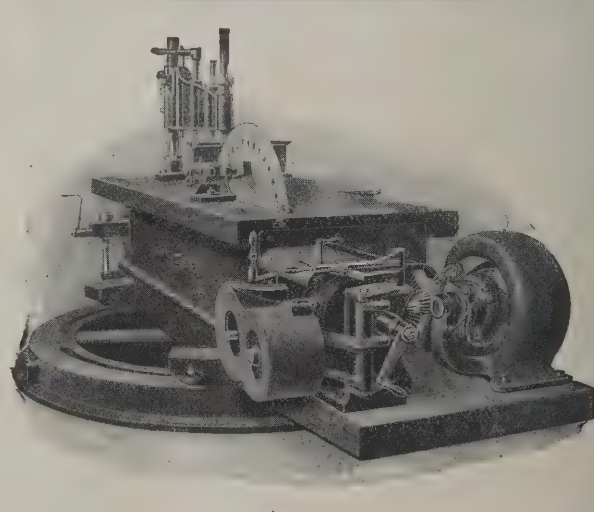

The Higley Metal Saw is built in 16 sizes. Over 2,000 in use.

Vandyck Churchill Company

NEW YORK PITTSBURGH
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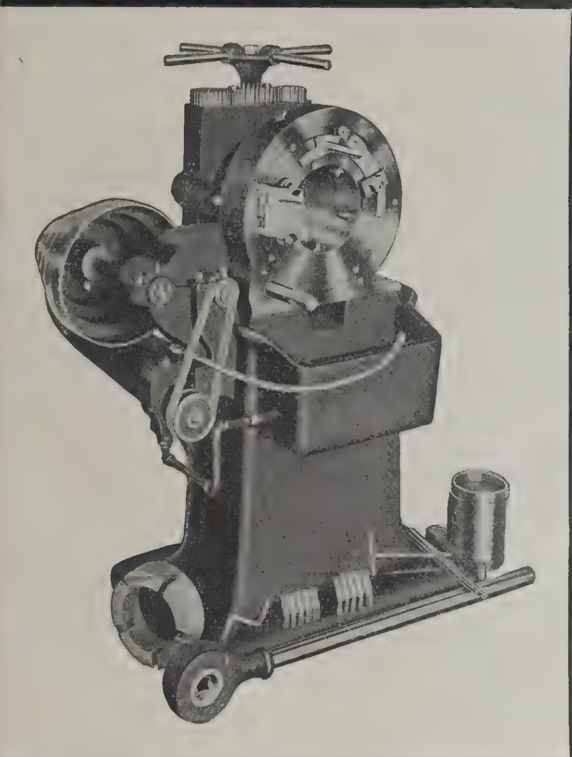
A STORY OF SATISFACTION



In an Ohio City one manufacturer has six

Merrell Pipe Threading and Cutting Machines

in daily operation. Some of them are 12 years old and were bought second-handed.

Every single machine is giving perfect satisfaction. "Everybody runs 'em," said the owner. "They're *always* busy; they never need any attention—we've never had to pay a repair or replacement bill."

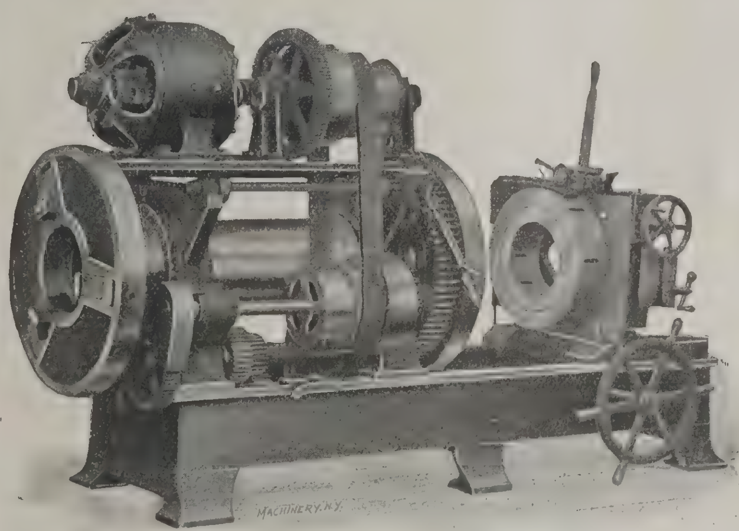
Another nearby manufacturer has had another make of threader one year. In this time the maker has had to send men to overhaul the machine four times. "I'm disgusted with it," he says—"we have to handle it with gloves—it's always out of order."

His is not an exceptional case. We guarantee **every** Merrell purchaser against pipe threading troubles. We send the Merrell **anywhere** for **30 Days' Free Trial.**

Will you write for literature?

THE MERRELL MFG. CO., 15 Curtis St., TOLEDO, OHIO

With Motor Drive the last touch of Modernity has been added to the Bignall & Keeler Pipe Machines



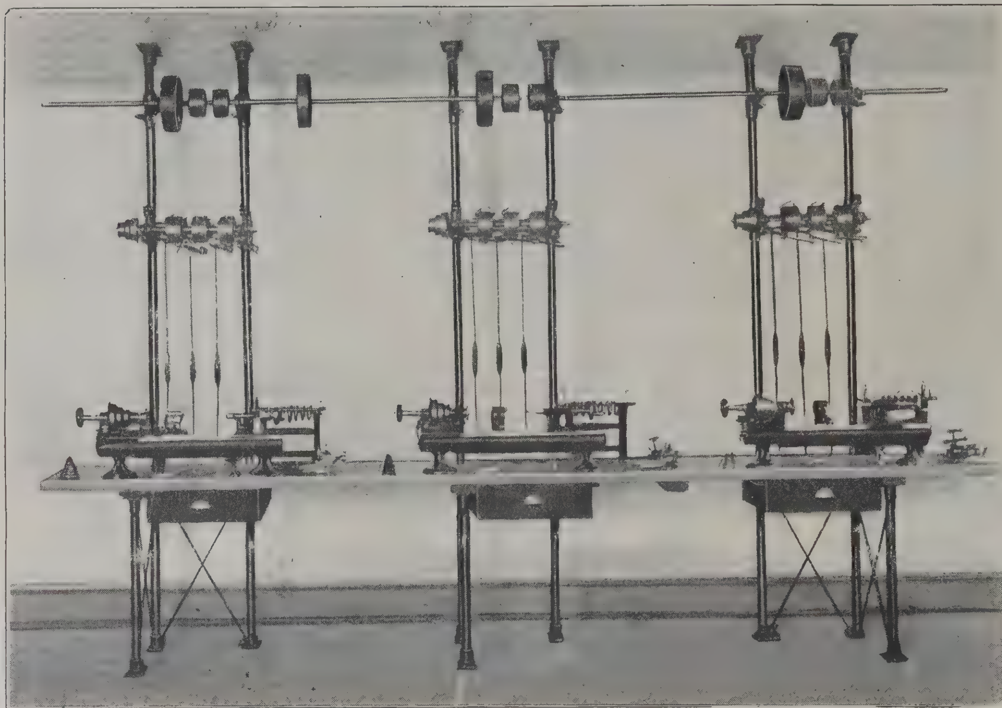
Our line is being constantly improved and new types added to meet new demands. The engraving shows a B. & K. Duplex Pipe Machine - the motor placed above the working parts, where it is out of the way and safe from oil and dirt. All necessary speed changes are obtained through the cones and shifting gears. Our famous "Peerless" die mechanism is incorporated in this machine, simple and dependable, with the cam ring graduated so it can be quickly set for different sizes of pipe. The chucks, two in number, are of the independent type, with three jaws.

Write us for full description, this is only one of seventeen styles and sizes we build, and we can fill almost any requirement in this class of work.

BIGNALL & KEELER MANUFACTURING COMPANY
EDWARDSVILLE, ILLINOIS, U. S. A.

FOREIGN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, St. Petersburg, Vienna, Stockholm. Alfred H. Schutte, Cologne, Paris, Milan.

Three Cataract Bench Lathes
Mounted on the Cataract Standard Bench



These machines are built in three sizes namely No. 3, No. 4 and No. 5, having chucking capacity from 1-64" to 1" inclusive. The patented features of the Cataract should be investigated.

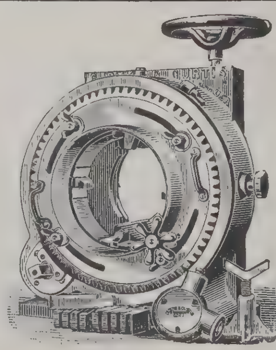
Write for Catalog '07.

We also manufacture the Beyer Watchman's Portable Clocks.

Catalog A-7.

This equipment is original with us.

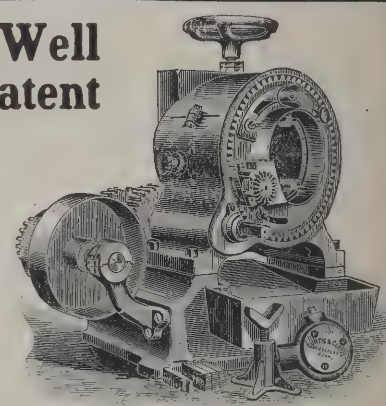
HARDINGE BROTHERS, Inc., 3133-3141 Lincoln Ave., Chicago, Ill.



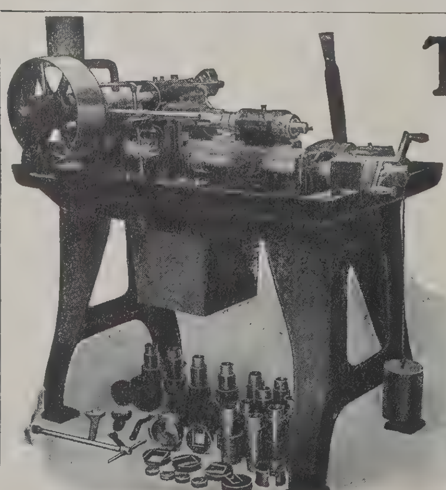
Write today for Catalogue.

Your Pipe Threading will be Well Handled if you use Forbes Patent Die Stocks

The Forbes returns dollar for dollar on the investment and the "returns" begin to come in as soon as the machine is installed. It's the labor saving, time saving, cost saving Pipe Machine you have been looking for. Compact and easily portable, it cuts and threads pipe under all conditions—in tight corners, trenches, narrow places. All parts interchangeable; provision made to take up wear. You can't afford to overlook its advantages.

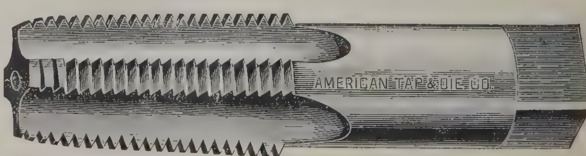


THE CURTIS & CURTIS COMPANY, 8 Garden St., Bridgeport, Conn., U.S.A.



THREADS 150 PER DAY

SIZE 1 INCH



That's just what one of our machines does with pipe taps, also the

THREADS ARE RELIEVED

and one man can operate 6 to 10 machines.

BICKFORD & WASHBURN, Greenfield, Mass. U. S. A.